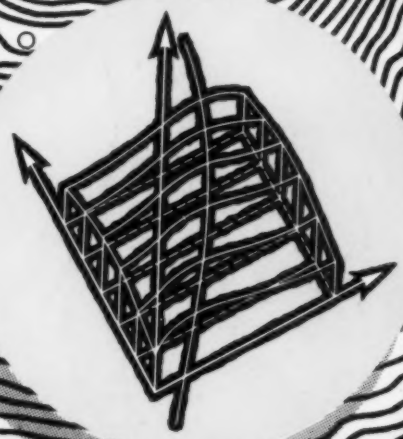
AUTOMATION

MAY 1958



Optimizing Process Operations

The Magazine of Automatic Operations

- Evaluating Equipment Costs
- Warehouse Order Processing
- Transformers Sense Feeble Position
- Feeding Electronic Parts

A PENTON PUBLICATION

How one precise adjustment started a new era in stamped metal production

It was back in 1954. A group of Wean Equipment Corporation executives and engineers were gathered around a bench-size prototype of an idea; an idea for a new kind of stamping press so revolutionary that it was decided to build a scale model embodying the principle before any development work was done on full-size equipment.

The group watched the Wean research director who had conceived and built the model make a careful final check; involuntarily held its breath while the switch was thrown. Nothing happened. In the short silence that followed no one moved . . . until, with a muttered comment, the research director directed one sharp blow at the side frame of the model with a lead hammer lying nearby.

The resulting clatter of the press, galvanized into action by this unexpected persuasion, heralded a new era in metalworking. For the "Flying Press" principle was first proved practical in that bench model; has been proved time and again in production size presses of from 20 to 300 ton capacity installed in forward-looking stamping plants.

We say "new era" because the "Flying Press" permits metal to be stamped and formed from coil without stationary indexing of the strip as it passes through the press. This continuous, uniform motion of metal through the "Flying Press" results in higher parts production from the same dies used in ordinary presses. But perhaps more importantly for the future, the "Flying Press" principle is unique, in that it matches press operation to the continuous-flow production techniques necessary for automated operations.

If you use stamping presses, you should know about this unique development that permits speeds never before possible while offering tooling protection, reduced die maintenance, and vastly reduced press maintenance requirements. There are too many other advantages of the Wean "Flying Press" to discuss here, but we've summarized them in a brochure. We'll be glad to send you this literature on request.

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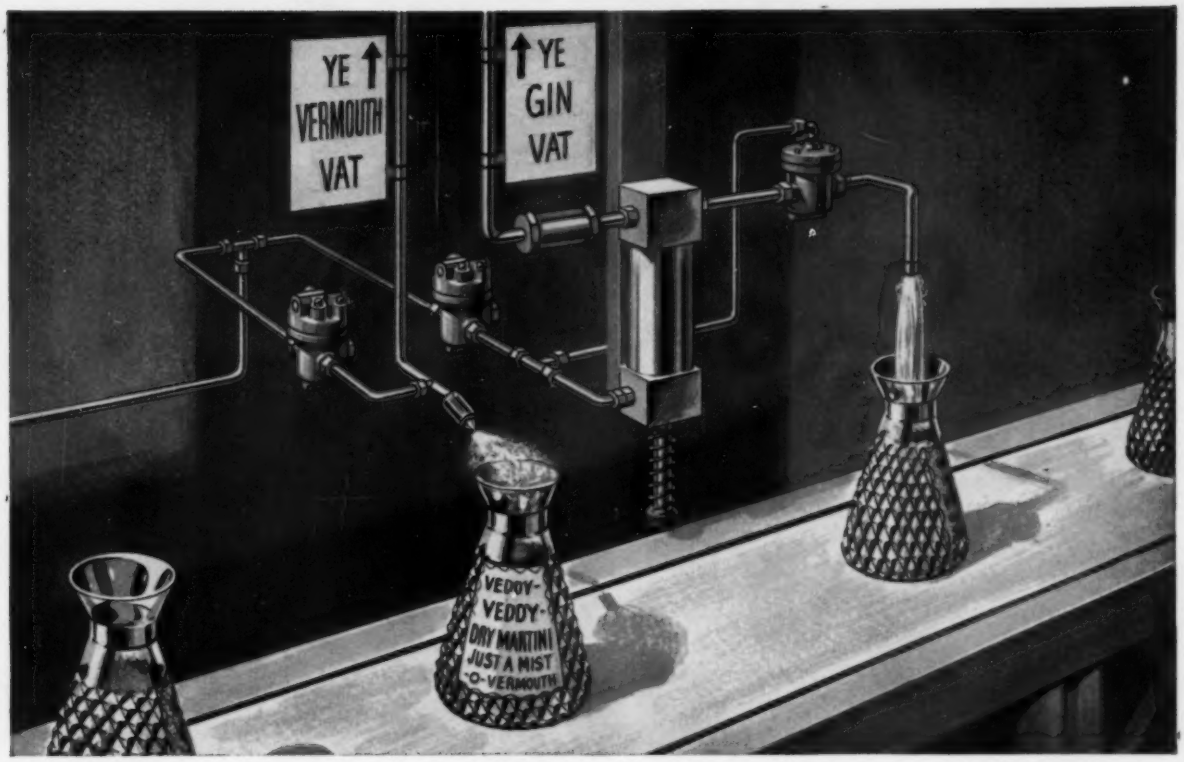


What? Air Automates the Extra, Extra-Dry Martini!

The ready mixed Martini may never come to this but . . .

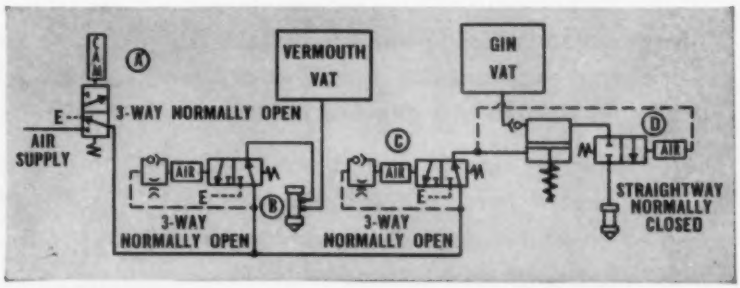
"Don't bruise the Vermouth!" Maybe you subscribe to the idea of only a fog of Vermouth or maybe you like yours four-to-one. But, if it came to bottling this vogue-ish mixture, the circuit here could certainly do it. Meanwhile it gives us a fanciful way to show you how you can easily create an all air circuit that does a continuous sequence of timed operations by using valves that can be both operated and sequenced by air. Every time the conveyor stops, it triggers the circuit.

Triggering one operation with another and timing the operating periods—all with air—may save the day for you.

The same air involved in the main operation can also pilot these valves. What's more these valves can be preset to wait out a time delay before operating, or operate for a self-measured time. Using them you can create unlimited all-air automation systems which could just turn the trick where you wish to avoid electricity, or want to stick with just one power medium.

SEQUENCE OF OPERATION

1. Conveyor indexes, opening cam valve (A). This introduces air to valves (B) and (C) which begin timing out. Vermouth is atomized by Vermouth nozzle, cylinder expels a measured amount of gin through master valve (D) which has been opened by air from the outlet of valve (C).
2. Valves (B) and (C) time out and close, stopping liquid flow.
3. Conveyor indexes again.



ROSS OPERATING VALVE CO. 131 East Golden Gate • Detroit 3, Michigan

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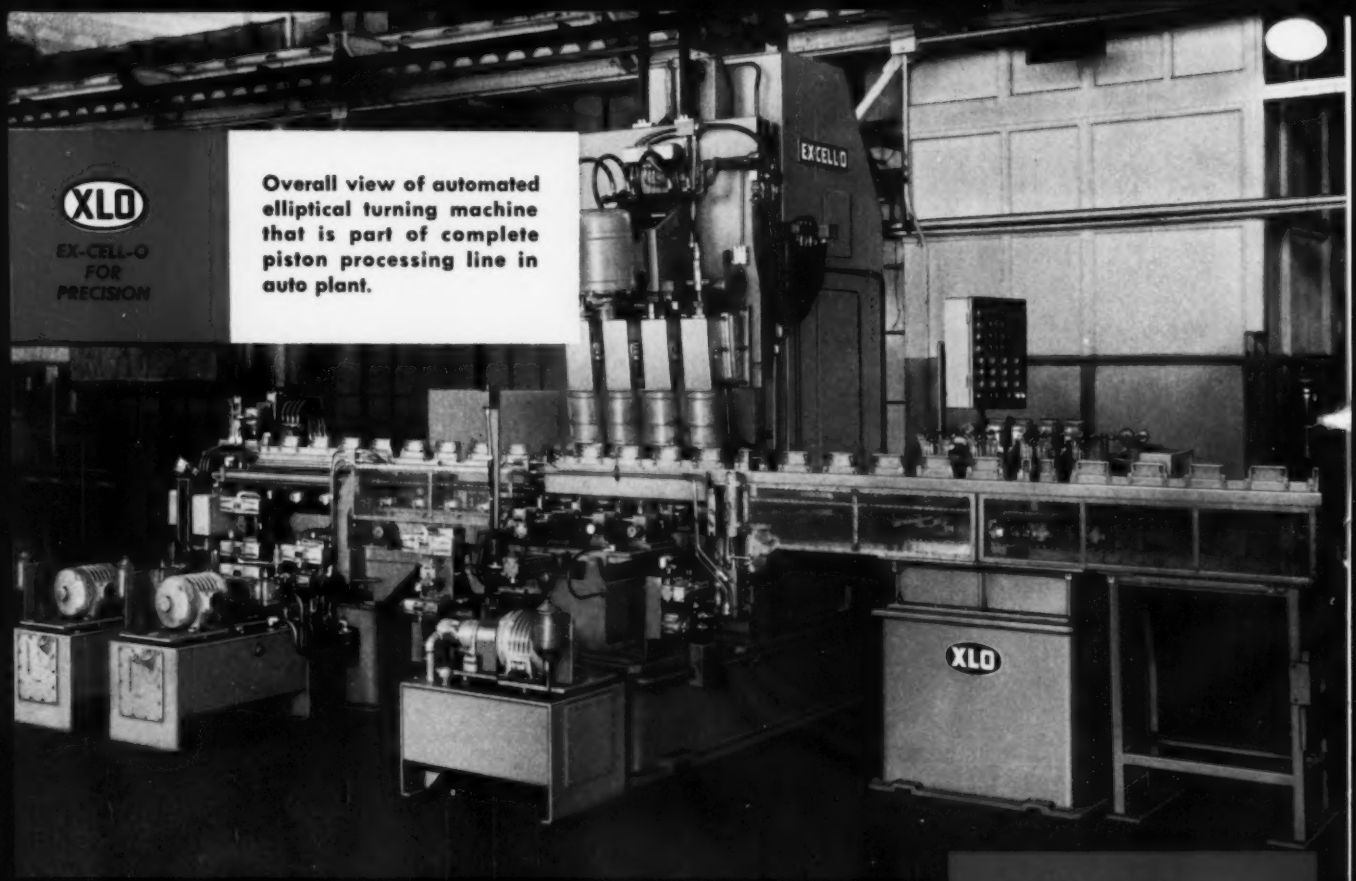

Overall view of automated elliptical turning machine that is part of complete piston processing line in auto plant.

Roughs and Finishes 250 Pistons per Hour

57-77

This automated Ex-Cell-O machine semifinish and finish turns an elliptical shape on automotive piston skirts at the net rate of 250 pieces per hour.

Pistons enter the machine from a conveyor, are radially located from their wrist pin holes and clamped on the ring land diameters. Four heads machine four piston skirts simultaneously. Air gaging follows the machining operation, after which pistons are ejected to another conveyor.

Write to Ex-Cell-O or contact your local representative for further information or a proposal.

EX-CELL-O CORPORATION *Machinery Division*
DETROIT 32, MICHIGAN

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MAY 1958
Vol. 5—No. 5

AUTOMATION

A PENTON PUBLICATION

The Magazine of Automatic Operations

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automation outlook

PRESCIENCE IN COST ESTIMATING

" . . . development, design, and construction of an automatic machine, particularly a new prototype, raise many interesting problems. Of these problems, one of the nastiest has always been, and still is, to estimate the cost of the project. Preparing such an estimate, before the design is well advanced, is frequently more difficult than the development of the machine itself. Today, more than ever before, management needs to know, in advance, the probable extent of development commitments. This means that the engineer must attempt to estimate costs before the mechanisms to be used are completely defined . . ."—*Robert G. Dexter, treasurer, Barkley & Dexter Inc., see page 52.*

WORK SIMPLIFICATION A FIRST STEP

" . . . when we think of automation, we think of replacing a manual operation with a mechanical operation. We are not thinking in terms of a better lathe or milling machine, but rather of substituting machines for the work previously performed by the operator . . . Since the complexity of a given mechanism will vary directly with the complexity of the manual operation which it is replacing, it follows that a reduction in the complexity of the manual operation will result in a requirement for a less complex and less costly machine . . ."—*Joseph G. Adiletta, assistant manager, Electronics Laboratory, American Machine & Foundry Co., see page 55.*

JUSTIFYING AUTOMATION EXPENDITURES

" . . . in this intricate and interesting field of automation it is not enough that the automation project be desirable to the engineer and the production man, it must also be desirable to the man who must approve the expenditures. This means the various advantages and disadvantages of the automation equipment over the present equipment must be translated into money. As the net advantage of the equipment, commonly called payoff, will significantly affect the decision to buy the new automation equipment, its preparation should be as thorough as the engineering study it represents . . ."—*Robert W. MacWilliams, supervisor of engineering, Management Services Div., Ernst & Ernst, see page 60.*

THE CASE FOR AUTOMATIC CONTROLLERS

" . . . the limitations of a human operator attempting to optimize a process are many, so that even if we insist on simplicity in an automatic optimizing controller, it can still outperform the human. It can, for example, have a more certain memory, a more intelligent search method, and the ability to handle more variables simultaneously. Furthermore, it can be made faster and more diligent than the human. In the game of outguessing a process, human interest can soon flag, while an automatic controller will always play at its best, and does not experience frustration . . ."—*A. Kerstukos and R. I. Van Nice, New Products Engineering Dept., Westinghouse Electric Corp., see page 71.*

PRODUCT RELIABILITY IMPORTANT

". . . this need for greater reliability—the quality factor—is not merely the province of the missile makers. It is vital to industrial and consumer product manufacturers too. In nonmilitary industries, the demand for higher reliability stems from factors of competition, automation, miniaturization, and from the need for greater safety, simpler servicing, and increased customer convenience. . ."—*H. Thomas Hallowell Jr., president, Standard Pressed Steel Co.*

AUTOMATION

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Published by

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Subscriptions in United States, possessions and Canada for home-addressed copies and those not qualified under above rules: One year $10. Single copies $1.00. Other countries: One year $20.

Published monthly and copyrighted 1958 by Penton Publishing Co., Penton Bldg., Cleveland 13, Ohio. Accepted as Controlled Circulation Publication at Cleveland, Ohio.

When requesting changes of address, etc., please allow four to six weeks for processing.

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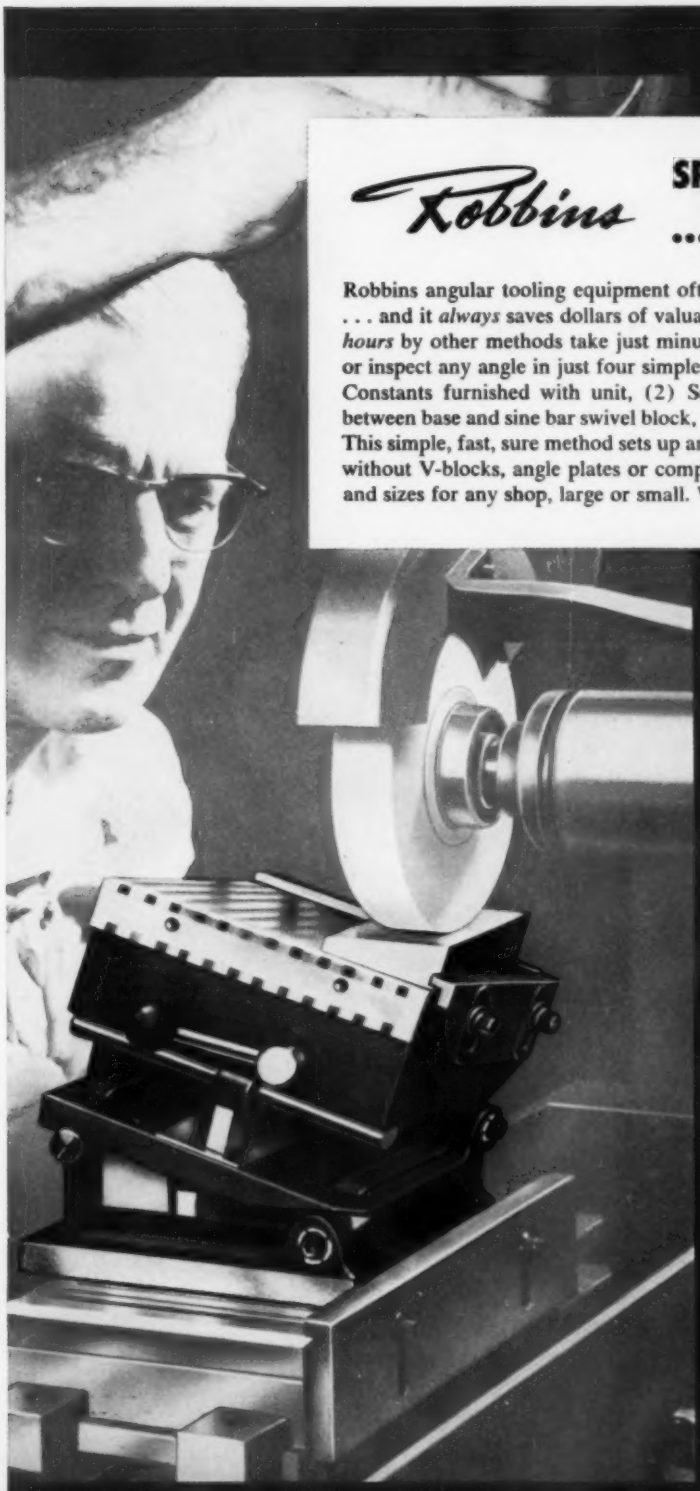

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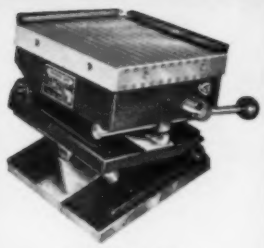
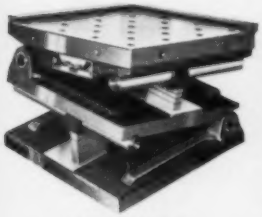


"MAGNA-SINE" WITH MAGNETIC TABLE



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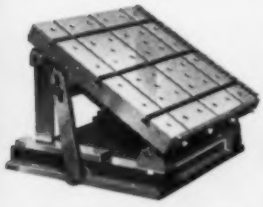

HEAVY DUTY SINE PLATE FOR MACHINING

OMER E. Robbins COMPANY

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Circle 656 on Page 165

Sectionized Transfer-matic Machines Hydraulic Steering Gear Housings

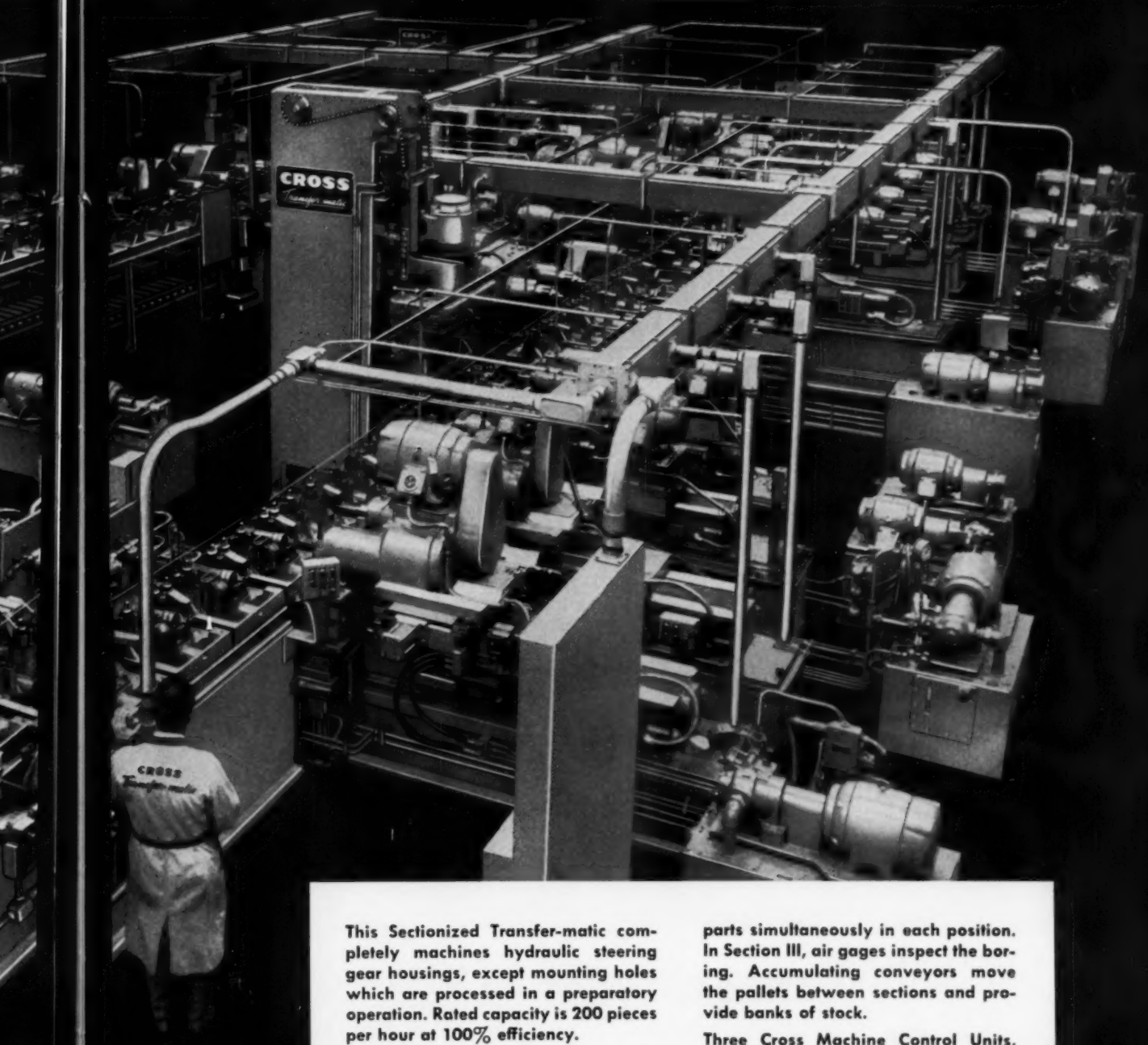
Established 1898

THE CROSS CO.

First in Automation

PARK GROVE STATION • DETROIT 5, MICHIGAN

Another Automation First by Cross



This Sectionized Transfer-matic completely machines hydraulic steering gear housings, except mounting holes which are processed in a preparatory operation. Rated capacity is 200 pieces per hour at 100% efficiency.

The housings are power clamped to pallet work holding fixtures which are transferred through three machine sections. In Section I, housings are milled, drilled, reamed, spotfaced, tapped and rough bored. Fixture clamps are then released to relieve machining strains. In Section II, single point precision boring completes the machining. Production is balanced by boring four parts simultaneously in each position. In Section III, air gages inspect the boring. Accumulating conveyors move the pallets between sections and provide banks of stock.

Three Cross Machine Control Units, with Toolometers to program tool changes, minimize downtime. Tool setting fixtures are provided to pre-set tools, thus eliminating trial cuts and adjustments.

Other features are complete interchangeability of all standard and special parts for easy maintenance, construction to JIC Standards, hardened and ground ways, and automatic lubrication.

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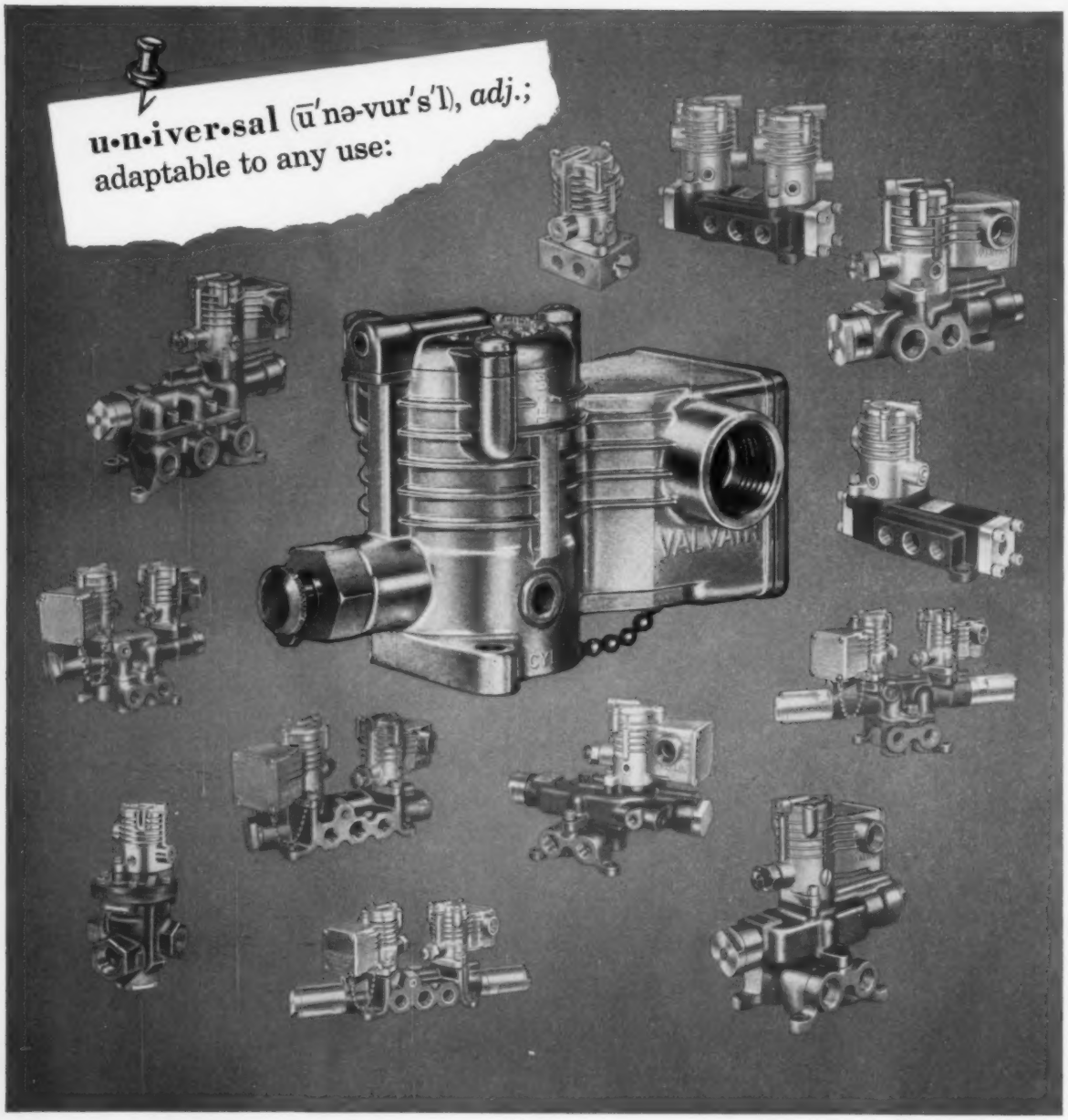

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Circle 658 on Page 165

AUTOMATION news

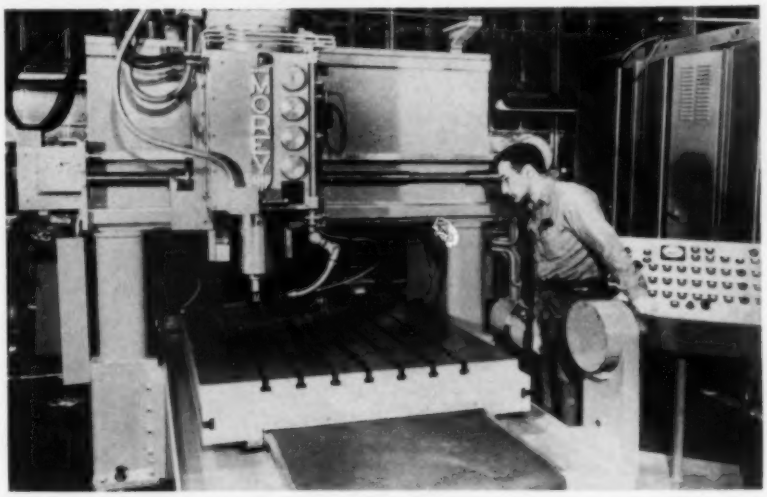
Today's events and developments in the field of automation

Magnetic Tape Control Applied To Small Milling Machine

MAGNETIC TAPE controlled profile and contour milling machine has been developed by Morey Machinery Co. Inc. to machine precision aircraft parts from ferrous and nonferrous metals. The control system for the new machine was developed by the Specialty Control Dept., General Electric Co. and is the smallest miller to which GE has ever applied this type control.

The milling machine is capable of handling heat-treated steels, aluminum, magnesium, and similar metals as large as 48 by 48 by 12 inches. A three-motion magnetic tape control system automatically directs vertical, horizontal, and longitudinal milling at rates up to 100 ipm and with tolerances as small as 0.001 inch. The cutting tool is continuously positioned with respect to the workpiece in accordance with a predetermined magnetic tape program. Instructions are programmed on 14-channel tape which can be stored when not in use.

OPERATOR inserts 14-channel magnetic tape in the tape transport of the General Electric numerical control unit. The tape controls vertical, horizontal, longitudinal, and return-to-start motions of the cutting tool.



PROFILE and contour milling machine developed by Morey Machinery Co. Inc. can be used as a conventional machine or can be controlled automatically by magnetic tape. The machine has a range of spindle speeds, varying in 16 steps from 20 to 3600 rpm, and can be used to machine ferrous and nonferrous materials. In the picture, the machine operator positions the table by handwheel prior to starting the automatic tape control.

The milling machine has three different types of controls incorporated in its design. Microdials and handwheels are provided for manual positioning and pushbuttons enable the operator to use the machine as a conventional milling machine. Automatic operation is controlled by the magnetic tape system.

According to **Leonard Morey**, president of Morey Machinery, "This high-precision miller and electronic control is now available for small lot production at a price the small and medium-sized plant can afford."

Dr. L. T. Rader, general manager of General Electric's Specialty Control Dept., estimated that: "Users of this electronically-controlled milling machine may expect manufacturing cost reductions of 35 to 69 per cent and savings in production time of at least 50 per cent. Users of similar machine tools equipped with GE controls have reported cost and production savings of these magnitudes."

The machine has a range of spindle speeds varying in 16 steps from 20 to 3600 rpm. When feed motions of all three axes are numerically controlled from magnetic tape, the cutter can be positioned or directed along a continuous path for all types of contouring operations. Parts may have regular or irregular shapes, straight lines, and angles or circles. The numerically controlled machine will produce complicated parts with minimum setup time, in small lots without skilled labor, and will assure accuracy and repetition. It is es-

pecially versatile for tool room as well as production application.

Self-Affixing Fastener Speeds Parts Assembly

ARRANGEMENTS have been completed by FabriSteel Products Inc. to make available nationally their patented "pierce nut" assembly technique which was originally developed for use in the automobile industry. Under the arrangement, Wales-Strippit Co. will manufacture an automated tool unit to apply the fasteners to products in all industries.

The pierce nut is applied by a single stroke of a standard press equipped with an automated tool which feeds and positions the nut above the material. On the downstroke of the press, the nut pierces its own hole and firmly affixes itself in the metal piece part. The threaded nut then serves as a fastener during the assembly of the part. **John H. Steward,** president of FabriSteel, said, "A standard press could produce up to 10,000 assemblies an hour."

The original pierce nut was developed for and with the aid of the automobile industry. However, its use required an expensive automation tool designed for attachment to large presses for high volume production. Working with engineers of Wales-Strippit, FabriSteel developed a new application tool designed for small presses used in moderate and short production runs. The new unit will be available to industry this year at a fraction of the cost of the original.

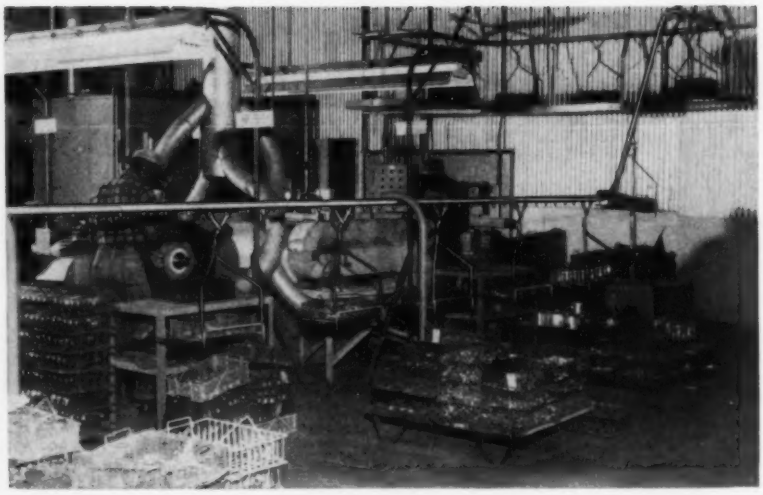
Westinghouse Unveils New Semiconductor Plant

MODERN plant for manufacturing semiconductor materials and devices was recently unveiled by Westinghouse Electric Corp. at Youngwood, Pa. The plant produces germanium and silicon power rectifiers, power and communications transistors, and silicon rectifier bridge assemblies.

The 160,000 sq ft plant is divided into functional areas which include both material preparation and device preparation. Included in the plant is a pilot facility to produce ultrapure silicon with less than one part impurity in six billion parts silicon. Westinghouse has licensed the process from Siemens Schuckertwerke and Siemens-Halske Companies in Germany.

Announced at the unveiling were several new solid state products. One was a new semiconductor rectifier that can operate at temperatures up to 1300F. This rectifier consists of a near-perfect crystal of silicon carbide that has been purposely "doped" by adding a small quantity of impurity. The location at which the doped and undoped sections of the crystal meet is called p-n junction and causes the crystal to act as a retcifier. In addition to operating when red hot, the new rectifier is small sized, has no moving parts, and has high efficiency.

Another new product announced was a silicon Trinistor triode—silicon switch—capable of blocking up to 200 volts and carrying current up to 10 amperes. A new series of silicon transistors for power applications have also been developed by Westinghouse. Two specific types of n-p-n fused junction devices have been produced—a 2-5 amp unit that can handle power up to 1 kw, and a 10-20 amp unit to handle power up to 3 kw.

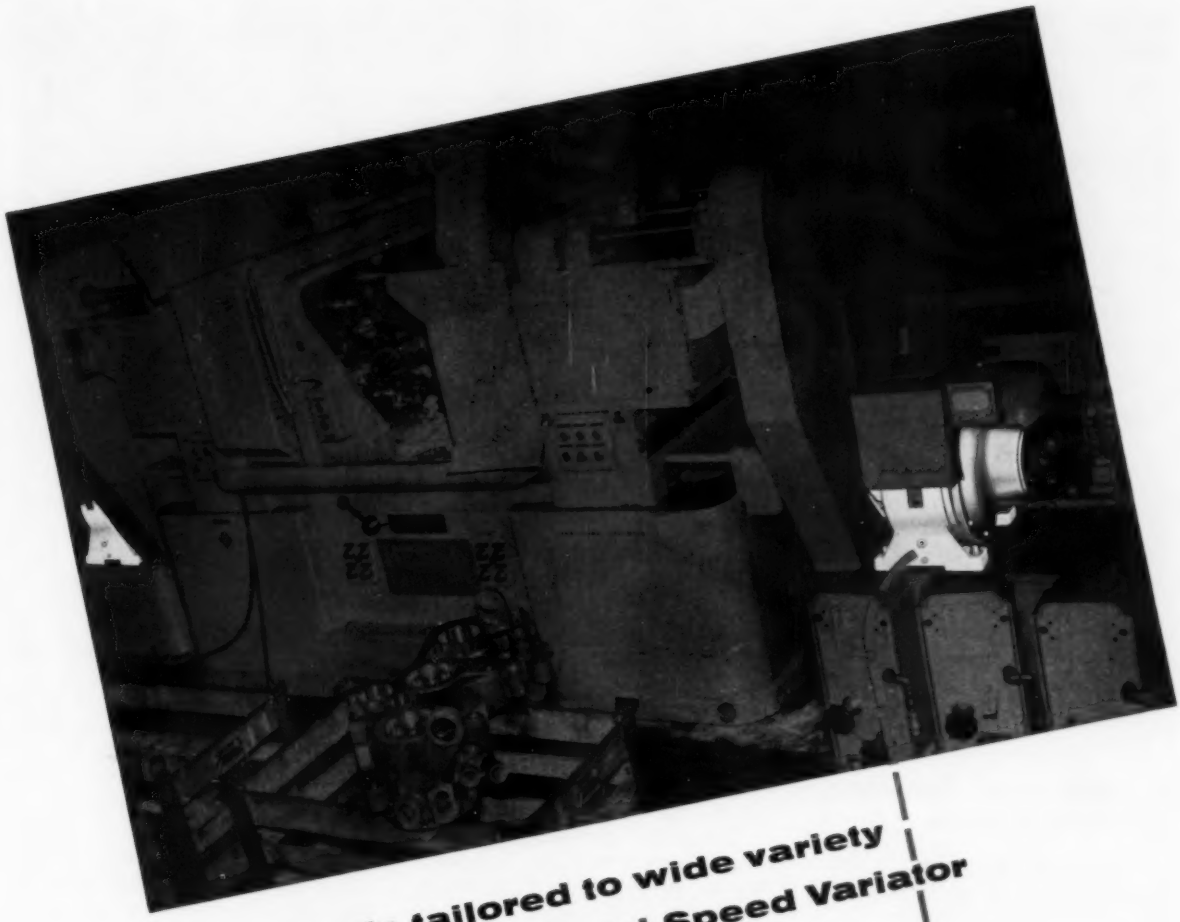


COST of moving intricate and odd-shaped plumbing fittings and fixtures has been reduced at Harcraft Brass, Div., Harvey Machine Co. Inc., through the installation of overhead conveyors. Working with engineers of Chainveyor Corp., Harcraft installed three overhead conveyor systems for moving products efficiently through the plant. First conveyor, shown above, carries wire baskets of parts to polishing machine operators. After polishing, baskets are replaced on conveyor and automatically transported through a washing machine which removes dirt, grit, and polish particles. Baskets are then moved by conveyor to plating room where parts are inspected and regrouped on racks on a second conveyor for transport through an automatic plating machine. After plating, parts are transferred to third conveyor for movement to final inspection and shipping.

Powder Rolling Mill Produces Metal Sheets

HORIZONTAL rolling mill which compacts metal powders directly into sheet and strip has been developed by Stanat Mfg. Co. Inc. The mill is designed to produce both ferrous and nonferrous materials in widths up to 7 inches and thicknesses ranging from 1/32 to 1/8 inch. The machine has successfully compacted such powders as aluminum, stainless steel, molybdenum, and tungsten.

The compacting-by-rolling technique can be used for both hot and cold rolling operations. Metal powder is poured between revolving rolls and a solid, uniform mass produced. Variables such as roll diameter, roll gap, and roll speed determine strip qualities. The rolls are arranged in a horizontal plane and a chute is provided to guide the strip from the rolls. Width of strip is controlled by side platens which are adjustable over the length of



Machining speeds tailored to wide variety of metals with Cleveland Speed Variator

In the manufacture of aircraft engine components, Cleveland Speed Variators permit fast, accurate adjustment of machining speeds to the exact rpm required for various metals from magnesium to 38 Rc steel.

Infinitely variable, the Speed Variator provides continuous speed progressions over its full 9:1 range . . . from ⅓ to 3 times input speed. Manual or automatic remote control instantly and smoothly adjusts output speed. Variator is rugged, compact, quiet running.

For full details—photographs, sectional drawings, rating tables, specifications—write today for Bulletin K-200. The Cleveland Worm & Gear Company, Speed Variator Division, 3265 East 80th St., Cleveland 4, Ohio.

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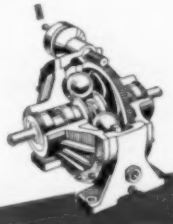
HOW IT WORKS

Power is transmitted from input shaft to output shaft through alloy steel driving balls which are in pressure contact with discs attached to the two shafts. Relative speeds of the shafts are adjusted by changing the positioning of the axles on which the balls rotate (see cutaway view, right).



CLEVELAND SPEED VARIATOR

Circle 659 on Page 165

the rolls. Finished strips can be made as narrow as ¾ inch and up to the width of the rolls. Flexibility of design permits the substitution of both wider and larger diameter rolls so that sheets up to 11 inches in width can be produced.

Laminations may be produced by directing streams of dissimilar powders into the roll gap. Powder may also be compacted between strips of wrought metal to form a "sandwich." Other materials such as cloth have been successfully impregnated with powder. Practically all metal powders compacted into strip must be sintered within a protective atmosphere such as hydrogen or argon to increase strength and ductility. The process is usually completed by rerolling the sintered strip in either a 2-high or 4-high rolling mill.

Electronic Postal Equipment Developed In Canada

DETAILS of an electronic mail sorting system being developed by the Canadian Post Office Dept. were revealed at the Institute of Radio Engineers convention held in New York during March. **Dr. Maurice Levy**, technical advisor to the CPO, outlined the automated system now being tested in Ottawa, Canada, and commented on future developments to be applied to the system.

The system is expected to reduce the time and cost of handling large volumes of mail by using electronic sorters. The first step in the system is to separate the mail to be handled automatically from regular mail. This is done by segregating letters having stamps impregnated with fluorescent material. Selected letters are then sent to an electronic printer. At this machine an operator reads the letter address and prints the information on the back of the envelope in code using fluorescent ink.

The coded mail is then sorted automatically on a conveyor system controlled by an electronic computer. Electronic sorters sense the coded address and route the letters to various containers for distribution to postal stations throughout the city.

Special attention given to coding techniques and error checking devices has reduced the possibilities of errors to one chance in 10,000 of a letter being misrouted. The codes being used have been selected so that the system may eventually be used internationally. At the present time the United States Post Office Dept. is working on an electronic mail sorting system which is expected to utilize a similar type of coding system.

Magnetic Rubber Provides New Handling Means

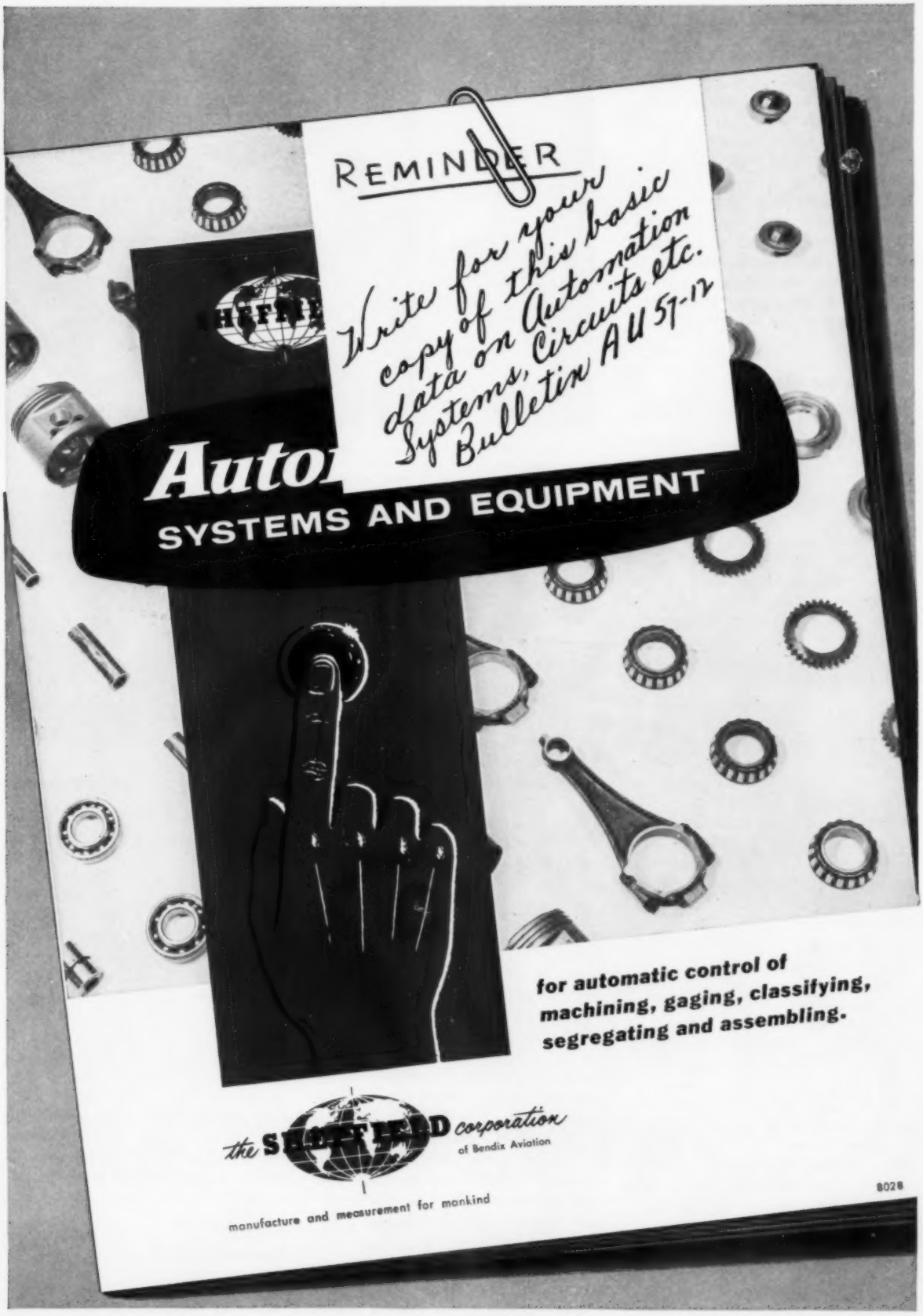
MAGNETIC RUBBER is a new product offered by Herr Equipment Corp. for use in handling ferrous materials and parts in metal producing, metal processing, and metal fabricating industries. The new material is produced by compounding Neoprene or other rubber and plastic substances with various permanent magnetic materials of small particle size.

The rubber provides a soft surface and prevents marring, scratching, or other damage to parts being handled. It can be fabricated into different shapes and can be compounded to produce either strong or weak magnetic fields. The magnetic material can be applied in a variety of patterns to facilitate handling or tracking. For instance, a roll can be treated so that the magnetic field forms a straight or spiral pattern, with nonmagnetic sections in between magnetic paths, so that the pieces handled are tracked and guided properly to the next operation.

Unlike other permanent magnetic materials, the treated rubber provides a low density magnetic flux over a large area rather than a high density flux concentrated in a small area. This provides an even, gentle pull over a large area instead of an intense pull over a restricted area.

One of the first applications of the new material is in feed rolls of an automatic stacker and feeder offered by Herr Equipment. The unit will stack or feed ferrous material from 12 by 12 inches up to 36 by 48 inches and up to 0.030 inch thick. It can handle square, rectangular, circular, or irregularly shaped pieces without marring or scratching the surface. In stacking, pieces are received from a process machine, carried on top of magnetic rolls, and then pass beneath other

AUTOMATIC bottling line with a capacity of 530 bottles per minute is now in operation at Genesee Brewery Inc. The new line can process up to 10,000 cases of 12-ounce bottles during an 8-hour day. Included in the line and connected by conveyors are a case opener, case cleaner, soaking and pasteurization unit, rinser, filler, photoelectric inspection unit, labelers, and a packer. Illustrated are conveyors leading to two of the four photoelectric inspection units built by Radio Corp. of America. Each unit can check up to 150 bottles per minute. Bottles containing foreign matter are removed automatically from the line. After inspection, bottles move to one of eight labelers which automatically modulate their speed according to the number of bottles on the conveyor line.


REMINDER
Write for your copy of this basic data on Automation Systems, Circuits etc. Bulletin AU 57-12
SYSTEMS AND EQUIPMENT
for automatic control of machining, gaging, classifying, segregating and assembling.
the SHEFFIELD corporation
of Bendix Aviation
manufacture and measurement for mankind
8028

magnetic rolls. When the piece contacts a back plate, it is tapped lightly from above and drops off the rolls to a stack immediately beneath. Feeding is accomplished in reverse order. Each piece is lifted off the stack with vacuum cups, carried beneath a set of magnetic rolls, and then across the top of another set of rolls. It is then guided into the feeding mechanism of the production machine.

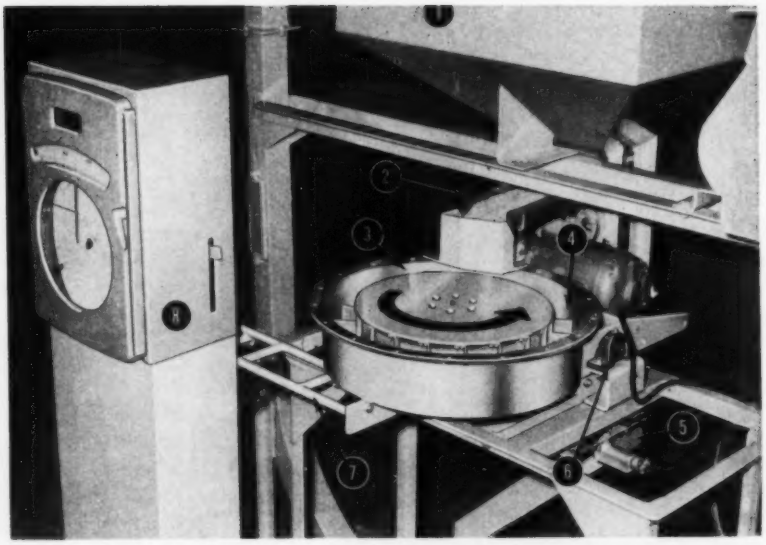
Self-Fluxing Electrode Adapted To Automatic Welding

AUTOMATIC high-speed welding process and equipment developed by Lincoln Electric Co. arc welds steel at speeds up to 300 inches per minute. The new process, called Innershield, uses a new type flux-containing, coiled hollow-wire electrode that produces a vapor shielding for an open arc.

All fluxing and shielding agents are integrally contained in the electrode and none are required to be added from an external source. In operation, the process maintains a visible arc between the work and the continuously fed electrode. The arc melts both work and electrode with the metal electrode serving as filler material. Some of the electrode's flux ingredients vaporize in the arc and shield it from the surrounding air. Other ingredients act as fluxing or deoxidizing agents in the molten pool. The new process does not produce the heavy slag usually associated with the submerged arc process. The resulting welds are dense and sound and have mechanical properties comparable to those required of submerged arc welds in commercial fabrication.

The new process and equipment were developed to reduce welding costs through higher welding speeds on jobs within its range and application. Speeds for 14-gage lap welds in the horizontal position range around 150 ipm. Under optimum conditions, speeds as high as 300 ipm can be attained. Lap welds in heavier material, such as 3/16-inch plate, range around 100 ipm. Typical jobs that can be handled by the equipment are small diameter circular welds, automotive parts, and pressure tanks.

Equipment for the process includes a welding head that controls the electrode feed and a motor-generator source that supplies 400 to 1000 amp welding current. The control circuit for the welding head adapts readily to machines and fixtures for high volume, production welding.



CONTINUOUS weighing device developed by Stephens-Adamson Mfg. Co. accurately weighs lump, granular, or flaky dry material during transfer from storage bin to conveyor chute. Device works as follows: 1. Material feeds from bin. 2. Vibrating feeder transfers material into weigher. 3. Revolving turret equipped with blades moves material around circumference of weigher. 4. Material drops from weigh pan into a chute. 5. Chute feeds weighed material into conveyor system. 6. During movement of material in weigh pan, weight causes pan to pivot on axis. 7. Mechanical linkage transfers weight to recorder in proportion to volume of material fed. 8. Recorder indicates material flow at any moment in pounds per minute, pounds per hour, or tons per hour. It also records flow rate for 24 hours and can record total weight from start to stop.

Carbide Dies Punch Plastic Bags

HIGH QUALITY carbide dies made by Kennametal Inc. are being used to punch ventilation holes in polyethylene bags for fruits and vegetables. Punching is done on a bag machine by two or more dies working in conjunction with cam-operated, spring-loaded piercing balls.

The carbide dies produce clean-cut holes as a continuous polyethylene sheet runs through the bag machine. Since the dies maintain their cutting edges longer than steel dies, machine shutdowns for changing dies have been reduced and longer production runs occur. Many regrinds of the cutting edges are possible since very little stock is removed each time. Expendable steel piercing balls are still used because of their low replacement cost.

Cake Baking To Be Automated

EQUIPMENT order exceeding $1 million has been placed by Kitchens of Sara Lee Inc. with the Food Div., Baker Perkins Inc. for automation machinery. The order covers machinery and allied devices for automating cake baking in Sara Lee's new plant under construction in Chicago.

Engineers from Baker Perkins, Sara Lee, and Union Steel Products Co. have combined talents to work out details for the new cake baking plant. Three specialized confectionary lines—coffee cake, chocolate cake and brownies, and cheese and pound cake—will be automated. The completed lines will double current output when in operation.

Electrohydraulic Servo Valve

ELECTROHYDRAULIC servo valve has been developed by Vick-

"3M-MATIC" taping and dispensing method speeds production . . .

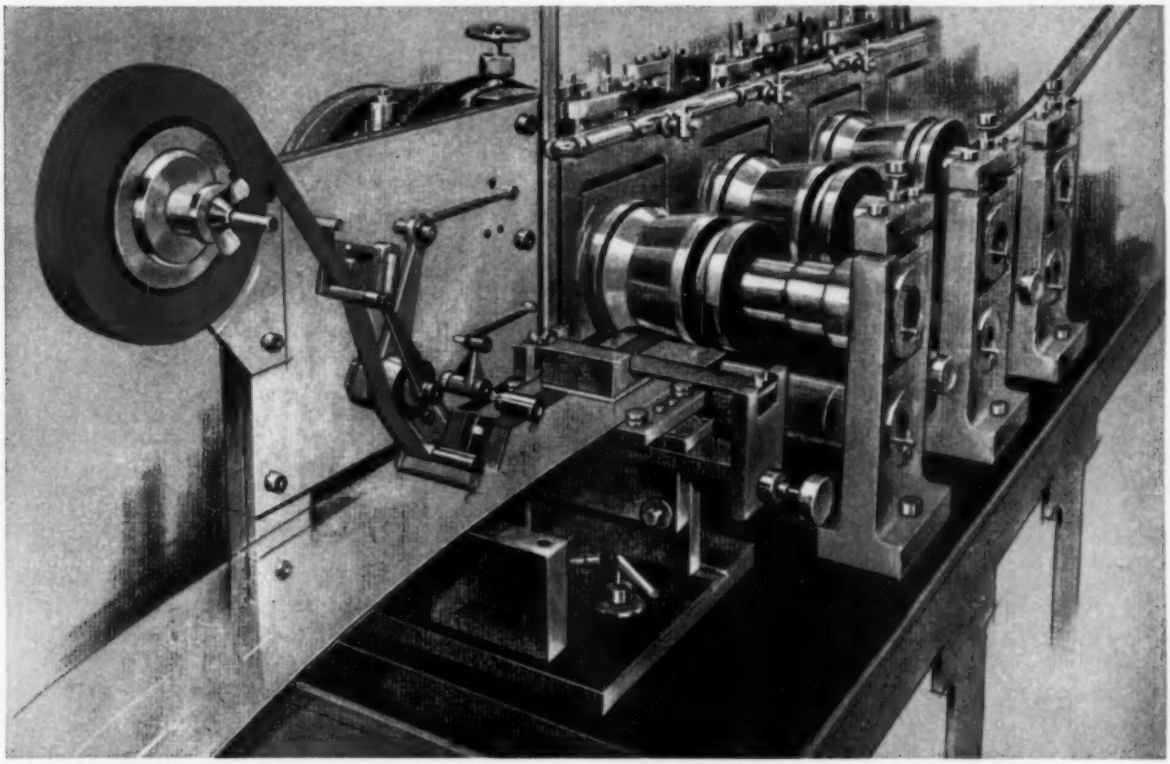
Protects 80-ft. of steel a minute!

How do you protect stainless steel ribbon from marring as it goes through cold-roll forming dies? Easy . . . strip it with tough "SCOTCH" Brand Polyester Film Tape. How do you apply the tape at production speeds of up to 80 feet a minute? Adapt a "SCOTCH" Brand Flat Surface Applicator to do the job *automatically*.

Finding the *right* combination of pressure-sensitive tape and dispensing machine for *your* particular need is the job of our Tape Specialists. They're experts on "3M-MATIC" taping and dispensing methods, and the world's most complete line of tapes—"SCOTCH" Brand. They'll help you get better results in less time, at less over-all cost.

And when the best "3M-MATIC" combination for your needs has been developed, the industry's largest and best-equipped distributor organization assures you of continuing prompt and dependable service. There's a "SCOTCH" Brand distributor near you. Call him for further information, or write Minnesota Mining and Manufacturing Company, Dept. ME-58,St. Paul 6, Minn.

"SCOTCH" is a registered trademark of 3M Co., St. Paul 6, Minn.



When tape costs so little, why take less than...

REG. U.S. PAT. OFF.

SCOTCH BRAND

MINNESOTA MINING AND MANUFACTURING COMPANY

. . . WHERE RESEARCH IS THE KEY TO TOMORROW

3M COMPANY

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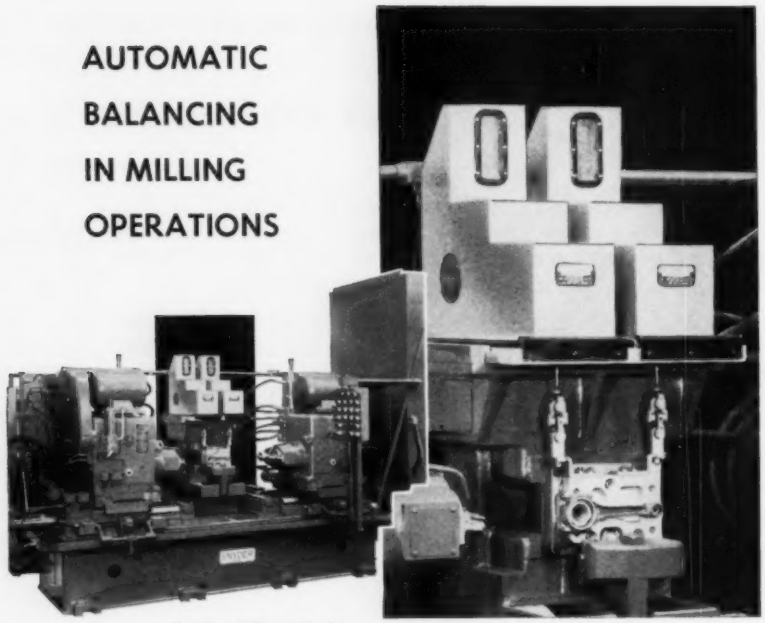
AUTOMATIC
BALANCING
IN MILLING
OPERATIONS



Snyder Milling Machine

SHADOGRAPH® SCALES . . .

- **determine weight distribution of connecting rods**
- **automatically set machine for correct stock removal**

Perfect Balance in connecting rods is assured by utilizing two Shadograph Scales integrated with the Snyder Milling Machine shown above. Operation is entirely automatic.

The Shadographs, employing a new concept of precision scales, are especially designed to weigh both ends of the work piece. Weight distribution of each piece is registered by the Shadographs and signals are transmitted automatically to stations on either side. Balancing is accomplished by one-pass milling to tolerances of 1/16 ounce (1.7 grams) in either end or overall weight. Rods which do not meet maximum milling dimensions are rejected automatically.

Shadographs and other Exact Weight Scales are used in many types of automated machines including food packaging, meat slicing and plastics weigh feeders. Write for complete engineering data.

THE EXACT WEIGHT SCALE CO.
907 W. FIFTH AVE., COLUMBUS 8, OHIO
In Canada: P.O. Box 179, Station S, Toronto 18, Ont.

Exact Weight SCALES

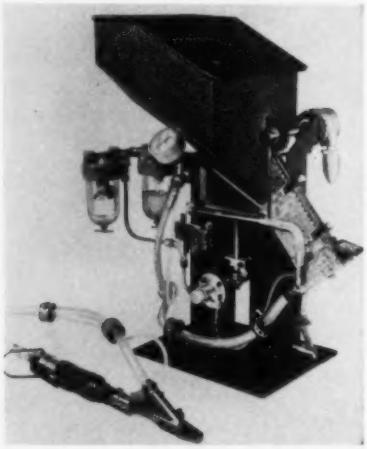
Sales and Service Coast to Coast

Find us in your local 'Yellow Pages'

BETTER QUALITY CONTROL . . . BETTER COST CONTROL

ers Inc. for use in machine tool and processing applications. The valve has only four moving parts—main spool, control spool, sleeve, and feedback linkage—and can be direct mounted or manifolded to a hydraulic motor.

The servo valve is designed for rugged use and can be applied to many industrial applications. Control signals for the servomechanism can be supplied by electrical transducers. The valve portion of the mechanism is rated at 10 gpm maximum flow and operates on supply pressures up to 3000 psi.



TAPERED plastic-covered head, adaptable to all types of power screwdrivers, has been introduced by Parker-Kalon Div., General American Transportation Corp., for use in driving threaded fasteners in confined locations. The new head is controlled by a pneumatic device which permits only one screw at a time to be fed from the supply hopper. Screws are blown from the escapement mechanism of the hopper through plastic tubing to a three-jawed holder where they are gripped as in a drill chuck. Holder retains the screw in driving position, regardless of the driving angle, so that the screw acts as a finder or drift.

King-Size Milling Machine

SPECIAL 40-foot long milling machine has been ordered by Baker Perkins Inc. for use in the manufacture of food and chemical processing equipment. The new machine will be capable of cutting various types of stainless steel mixing screws, ranging from 4 to 30 inches in diameter with flights up to 14 feet. Innovations of the new machine include an independently-driven vertical milling attachment for roughing out flights and a

Circle 662 on Page 165

Circle 721 on Page 165→

ALLEN-BRADLEY

new

BULLETIN 350 reversing drum switch

Styled by Brooks Stevens, internationally famous industrial designer.

- *MODERN IN APPEARANCE*
- *AVAILABLE AS OILTIGHT— FOR CAVITY MOUNTING*
- *EASY TO MOUNT*
- *EASIER TO WIRE*
- *INSTANT CHANGEOVER FROM MAINTAINED TO MOMENTARY CONTACTS*

A-B QUALITY

ALLEN-BRADLEY

MOTOR CONTROL

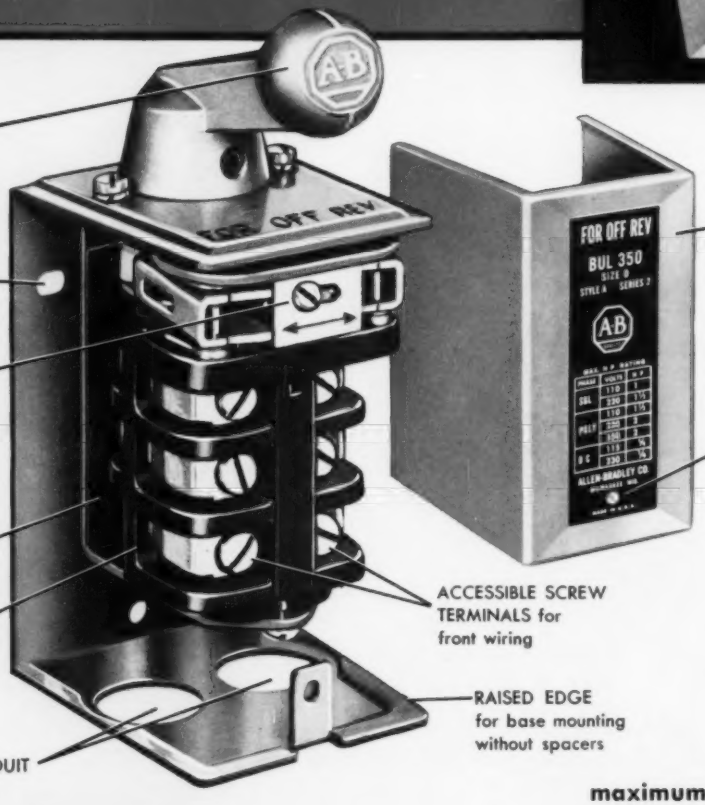
QUALITY

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.
In Canada—Allen-Bradley Canada Ltd., Galt, Ont.

6-58-MR

A new "quality" standard for small REVERSING DRUM SWITCHES

A-B QUALITY



GOOD-LOOKING AND GOOD "FEELING" DIE CAST HANDLE

EASILY ACCESSIBLE MOUNTING HOLES

MERELY LOOSEN SCREW AND SLIDE PLATE to change from momentary to maintained contacts —or vice versa

INDEPENDENT SWITCH MOUNTING prevents misalignment

HEAVY CONTACT SURFACES for long operating life

TWO CONDUIT OPENINGS

WRAP-AROUND COVER gives complete access to drum

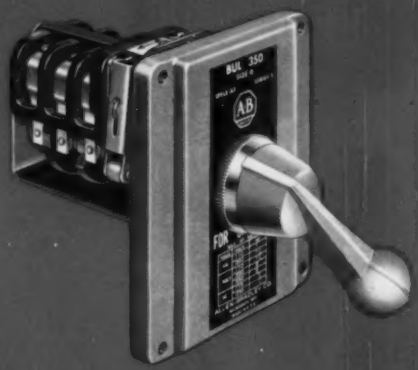
SINGLE SCREW COVER MOUNTING —screw cannot fall out

ACCESSIBLE SCREW TERMINALS for front wiring

RAISED EDGE for base mounting without spacers

maximum rating 2 horsepower

NEW OILTIGHT COVER PLATE FOR CAVITY MOUNTING



Bulletin 350 Reversing Switch can be furnished with oiltight cover plate with rubber gasket seal for cavity mounting in a machine base.

This *all-new* Allen-Bradley reversing drum switch was designed to keep pace with the mechanical beauty designed into so many of the modern machine tools.

The Bulletin 350 reversing switch is equivalent to a three-pole, double throw switch . . . and can be used with d-c motors; or single phase, two phase, or three phase a-c motors.

Investigate the Bulletin 350 . . . the *new leader* of its class . . . in appearance, ease of installation, and operating life. An Allen-Bradley *quality* switch . . . in every sense of the word. Send for descriptive bulletin.

ALLEN-BRADLEY

MOTOR CONTROL

QUALITY

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.
In Canada—Allen-Bradley Canada Ltd., Galt, Ont.

6-58-MR

powered conveyor capable of handling a cubic yard of metal chips per hour. The new machine tool will be built by Cincinnati Milling Machine Co.

SECOND automation movie has been released by General Electric Co. in connection with its "More Power to America" program and is entitled "Automation and Mr. Halstead." Building flexibility into automated processes by exploiting recent advances in the electrical field is covered in the new film. Examples of automation include descriptions of a program controlled milling machine and an automatic warehouse installation.

Punch Press Protection Device

ELECTRONIC device has been developed by Goldak Co. Inc. to detect the presence of metal objects as they are ejected from a punch press. Designed to operate on presses running at speeds up to 150 strokes per minute, the device, known as Detrex, will stop a press when any metal object fails to arrive at the detection head within a predetermined time. By stopping the press before the downstroke is completed, the unit will prevent

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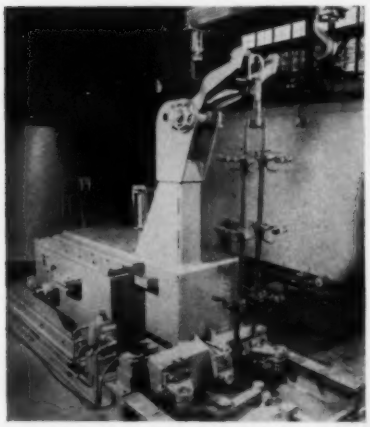


TRANSFER device developed by Equipment Div., Wagner Bros. Inc., transfers individual parts and work in baskets or on racks between conveyor systems. Unit reciprocates back and forth on cam on left side of device which is adjustable for length of stroke. Picture shows unit moving a rack from hook in background to hook on right. Completely automatic, device can be synchronized with speed of conveyors and can be powered hydraulically or electrically.

Make your products cost less...

"AUTOMATE" operations with a

Feedall

BAR FEEDER

- *fast and versatile*
- *has adjustable work-range*
- *feeds high-speed production units*

SPECIFICATIONS
Model 1700C
Bar Feeder

FEED RATE: 50 pieces/minute maximum.

RANGE: feeds parts 1/4" to 2" diameter (std), 6" to 31" in length (std). Other ranges of diameters and lengths available.

BELT SPEED: variable from 5 to 20 fpm (std). Other speeds available. Cycling rate controlled by conveyor speed, photoelectric relay or mercury switch.

SPACE: 34" x 36", approx. 60" high.

Automatic, self-powered bar feeders make surprising cost-savings on high-speed production operations. They eliminate costly hand-feed, speed material handling and production, maintain parts flow at a smooth, continuous rate of output.

Take Model 1700C, above. It feeds bar stock up to 50 pieces a minute. Feeder replaces operator, is faster, less expensive. And Model 1700 C is versatile: convenient hand-wheel provides quick adjustment to accommodate bars of different lengths. Variable speed drive adds still more flexibility, economy.

There's a saving, too, in the compact, "complete package" installation with self-contained power unit. The Model 1700 C also is easily combined with a wide range of production machines.

Details describing the Feedall 1700 C Bar Feeder are now available with the latest catalog and including a time-saving estimate data sheet. Write for your copy today. If you have a special feeding problem, send us sample parts and brief data. We'll do the rest, promptly.

Feedall

Producers of automatic feeding devices
FEEDALL, INC., WILLOUGHBY, OHIO

ELEVATING, BLADE, TUMBLE, VIBRATORY FEEDERS • TRANSFER AND ELEVATING CONVEYORS • SPECIAL SELECTOR DEVICES

"Snap-Slide" Construction Permits 20-Second, 5-Step Disassembly,

100 LINE

20-SECOND

1

LIFT THE SPRING-CLAMP COIL TERMINALS. The entire magnet assembly can now be easily removed. Notice that you don't have to disturb any wiring, and you don't even need a screwdriver.

2

REMOVE THE MAGNET ASSEMBLY. Both stationary and movable contacts are clearly visible and can be inspected at a glance. All starter components snap or slide together.

3

Makes the NEW General Electric Size 0 and 1 MAGNETIC STARTERS

EASY TO MAINTAIN

You can inspect the contacts of the new, radically different General Electric starter in 10 seconds or disassemble the entire starter in 20 seconds without tools. It's simple, and made possible by General Electric's new "snap-slide" construction—all the principal components snap or slide together.

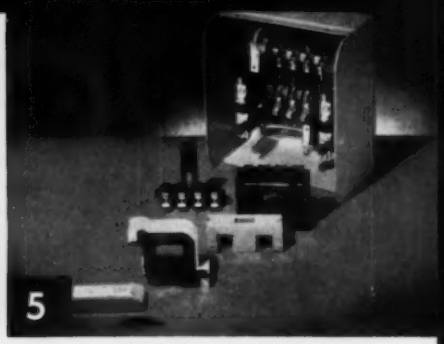
Like more information? Contact your nearby General Electric Apparatus Distributor, or write to Section 733-41, General Electric Company, Schenectady, New York and ask for bulletin GEA-6611.

Also ask about the new General Electric manual starter for single-phase fractional-horsepower motors. It has the exclusive plug-in heater that can be installed in a few seconds. The new starter fits any standard wall box. Ask for bulletin GEA-6358. General Purpose Control Dept., Bloomington, Illinois.

DISASSEMBLY—WITHOUT EVEN A SCREWDRIVER

REMOVE THE ARMATURE SPRING CLIP. Slip it out of the slot in the "I" magnet. This little spring clip is the key that unlocks the entire assembly of the new General Electric magnetic starter.

LIFT OUT THE CONTACT ARM. The coil, the "E" magnet, and the arc chute cover will now slip apart. Notice how the vertically slanted contacts are designed to resist dust and dirt.

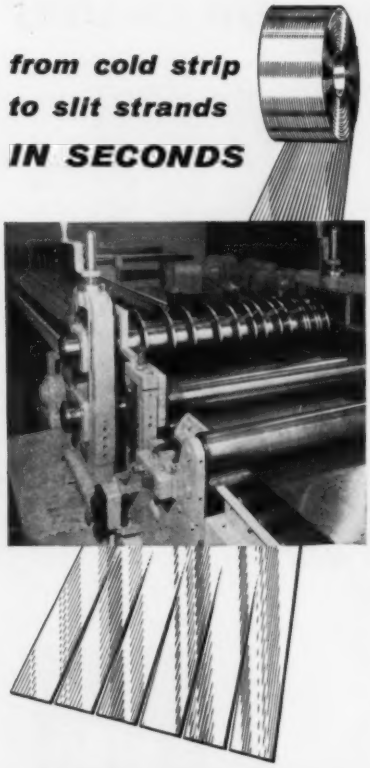


DISASSEMBLY COMPLETED. All principal components have been separated in 20 seconds. This new construction gives fast simple inspection and maintenance—without tools.

GENERAL ELECTRIC

Circle 664 on Page 165

from cold strip
to slit strands
IN SECONDS



YODER ROTARY MULTIPLE SLITTERS

A Yoder slitter converts mill-width coils of flat-rolled metal into many variable-width strands in amazingly short time. Speed, coupled with great accuracy and low manpower requirements, makes a Yoder slitter an important factor in keeping production and overhead costs down.

Operated by only two men, the Yoder Type 3-48 slitter illustrated is designed to accommodate standard mill-width coils up to 48 inches wide, in a variety of metals and thicknesses. The slit strand widths can be held to within a .004" tolerance.

Even if your steel requirements are as little as 100 tons a month, the savings to be realized in time, manpower and raw material costs alone will pay for a Yoder slitter in the first few months of operation.

There is a Yoder slitter designed and engineered to meet your requirements, and to speed the delivery of "special" width stock in a wide range of large or small sizes. Send for your free copy of the fully-illustrated, 76-page booklet, "Multiple Rotary Slitting Lines."

THE YODER COMPANY
5528 Walworth Avenue • Cleveland 2, Ohio

ENGINEERING YODER MANUFACTURING
ROTARY SLITTING LINES

Circle 665 on Page 165

TABLE TOP special purpose analog computer, designed primarily to solve office and factory business production problems, has been introduced by General Electric Co. Typical problems which can be solved by the computer include production scheduling, materials explosion, work station load impact, and similar situations. No special installation is required and the computer can be plugged into any 115v ac power outlet. The unit is suitable for both factory and office use since construction is rugged and blends with most decors.

damage to the dies and the press.

The unit consists of a control box and detection heads which are tied in with the press brake or clutch. The control box employs tubes and transistors and is designed to be mounted on the press. The unit is flexible in design and can be tied in with any type of alarm or control system.

SPOTLIGHTING PEOPLE

Roy Prochnow appointed assistant to the director of operations for Clearing Machine Corp. . . . **Carl F. Carlzen,** mechanical engineer, joined the Control Systems Div., Ramo-Wooldridge Corp. . . . **William D. Marshall** appointed assistant to product manager for Electrical Mfg. Div., National Acme Co. . . . **Dan E. Harrison** appointed vice president and general manager of the Midwestern Div., True-Trace Sales Corp. . . . **George J. Crowdes** appointed chief control engineer of Assembly Products Inc. . . . **C. Glen Bigelow Jr.** appointed director of research for Selas Corp. of America . . . **Frank Kaman** named chief air tool engineer, **Peter Rebechini** appointed chief electric tool engineer, and **James A. Perham** appointed chief product engineer for the Aurora Works, Thor Power Tool Co. . . . **Kenneth H. Meyer,** director of engineering, elected vice president of C. B. Hunt & Son Inc. . . . **Ira F. Gilliatt** elected president of Conveyor Specialty Co. . . . **Leon Weiss** joined Electronic Control Systems Div., Stromberg-Carlson, as a staff engineer . . . **Ernest Auerbacher** elected vice president of Alvey Conveyor Engineering Co. . . . **J. M. Cook** appointed vice president in charge of marketing and **P. S. Jones** named senior vice president of Cutler-Hammer Inc. . . . **Phillip Hall** appointed manager of industrial sales for A. Schrader's Son, Div., Scovill Mfg. Co. Inc. . . . **Lee L. Bushong** appointed manager of manufacturing equipment development, **Sydney O. Johnson** named manager of transistor advance and design engineering, and **Martin E. Clark** appointed manager of transistor product engineering for Semiconductor Products Dept., General Electric Co. . . . **Richard E. Frederick Jr.** appointed plant manager of the card manufacturing plant, Supplies Div., International Business Machines Corp. . . . **H. E. Temple** joined Baker Perkins Inc. as director of research and development . . . **Carl S. Saltzman** named manager of Controls Systems Co., Div., Hancock Industries . . . **E. E. Saloum** appointed chief engineer for Snap-Tite Inc. . . . **Donald G. Dutcher** joined Hanson-Van

THEY'RE ALL ROBO-WRAPPED! Blumenthal Raisinettes and Goobers, Federal Plastic Tableware, Perm-O-Seal, Schrafft's Gums and Jellies, Chunky Chocolate Squares, Tom's Corn Cheez, General Mills Wheaties and Cheerios, Kraft Miniature Marshmallows sample package.

FORM, FILL, SEAL AUTOMATICALLY

PILLOW-PACKAGING CUTS COSTS

Does your product belong in this picture? It does if automatic packaging can save you money. Doesn't matter whether you package solids, powders, granules or liquids . . . Robo-Wrap heat seals them in a single or double wall of cellophane, paper, polyethylene, Foil Laminates, Mylar or Saran. Hand-over-hand method forms, fills and seals packages from a continuous roll for highest efficiency. Robo-Wrap changes package size quickly, too. Write for booklet that gives facts on low maintenance and higher efficiency.

LYNCH ROBO
CORPORATION
A Subsidiary of
LYNCH CORPORATION
Anderson, Indiana

Circle 666 on Page 165

with the **LIPE Automatic MAGAZINE LOADING BAR FEED"**

says Screw Machine Foreman Willis J. Forbes*

Up to six months ago, the record per-machine production in our department for a single day was 5760 pieces. Our best monthly average was 5300 pieces per day. We tried out a Lipe A.M.L. to feed one machine, turning at the same cutting speed as before. In the first full day of operation, the A.M.L.-fed machine matched our top monthly average by 1:25 P.M. . . . and ended the day at 4:00 P.M. with a production of 7823 pieces! It has continued to turn out that number daily, *for six months!*

Why? The Lipe A.M.L. feeds stock continuously: No repeat motion for feed-outs. No down-time for changing feed fingers, or for remnant disposal. No cutting air—and when you stop cutting air, you start cutting costs. That's why we are now equipping our department throughout with Lipe A.M.L. Bar Feeds.

WRITE OR WIRE for a FREE Lipe Sales Engineering estimate of production increases, savings and amortization time of Lipe A.M.L. Bar Feeds in your production layout.

*Photographer's models and pseudonyms used to protect company identity and confidential information.

Lipe-ROLLWAY CORPORATION SYRACUSE 1, N.Y.

MACHINE TOOLS • HEAVY-DUTY AUTOMOTIVE CLUTCHES • PORTABLE POWER HACK SAWS

Circle 667 on Page 165

Winkle-Munning Co. as chief electrical engineer . . . **Herbert W. Ziebolz** appointed co-ordinator of industrial systems and assistant to the vice president of engineering for General Precision Equipment Corp. . . . **Bruce D. Miller** named vice president of manufacturing, **Allen M. Bond Jr.** appointed director of engineering and product development, and **N. T. Joyner** named general sales manager for Girdler Process Equipment Div., National Cylinder Gas Co.

SIX-CHANNEL programmer available from Beattie-Coleman Inc. is designed to control a number of precisely timed functions at preset intervals. A sensing device reads pulses through holes or slots punched in six-channel Mylar continuous loop tape. Current transmitted through the sensing device actuates six single-pole, double-throw relays which are connected to loads through external taps. A device is available to punch holes in the tape with an accuracy of ±0.001 of a second.

SPOTLIGHTING PRODUCTS

Water-soluble rust preventive protects metal parts during indoor storage for 2 years or more. It deposits a thin, transparent polar film which will not re-emulsify or wash off after drying. Wetting out property allows the film to creep over uneven and unclean surface to form a continuous coating. Tests indicate that the coating need not be removed prior to machining operations or painting. The odorless and nontoxic preventive is manufactured by G. W. Smith & Sons Inc. . . . *Silver clad stainless steel* is being used as an efficient, inexpensive, and durable electrical contact material. It is made by metallurgically bonding a thin layer of silver to type 430 stainless steel and

THE IMPACT OF *Automation* ON TODAY'S BUSINESS

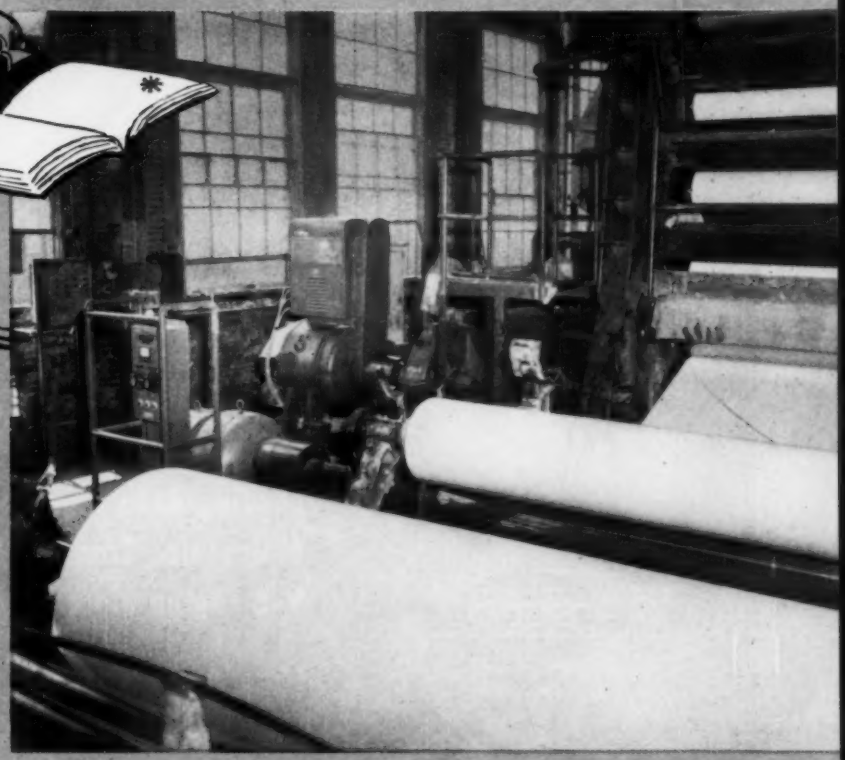
* Your name will appear in print here

This machine produces the paper for the much-used telephone books, without which making a telephone call could be a bothersome task.

This paper machine is an outstanding example of automation. Wood pulp which is 99.4% water, is fed into the machine. It is drained, squeezed, pressed, dried and wound onto rolls as finished paper stock.

The paper industry depends entirely on automated machines such as this to keep up with the demand for paper and paper products. Directly employing over 453,000 workers, last year the paper industry produced 30,000,000 tons of paper for a per capita consumption of 419 pounds.

None of this would have been possible without the modern techniques of automation. More than a wise capital investment, automation is a general benefit to the economy of this nation.



HORSEPOWER FOR AUTOMATION BY RELIANCE

The eight sections of this machine are driven by a Reliance Sectional Electric Paper Machine Drive, incorporating approximately 600 hp. The machine is used to produce nineteen to thirty-two pound paper stock in 174" widths. This is the type of paper commonly used for telephone books.

Formerly limited to a range of from 400 to 800 fpm. the machine is operated now at a rate of from 400 to 1200 fpm. The Reliance Paper Machine Drive maintains perfect synchronization between each section of the machine. Without this synchronization the paper would tear, causing unnecessary shut-down and delay.

If you would like further information on Reliance Drives, write for Bulletin A-1555-B, "Widening the Horizons of Automation".

RELIANCE ELECTRIC AND ENGINEERING CO.
DEPT. 315A. CLEVELAND 17, OHIO
CANADIAN DIVISION: WELLAND, ONTARIO
Sales Offices and Distributors in Principal Cities

Circle 668 on Page 145

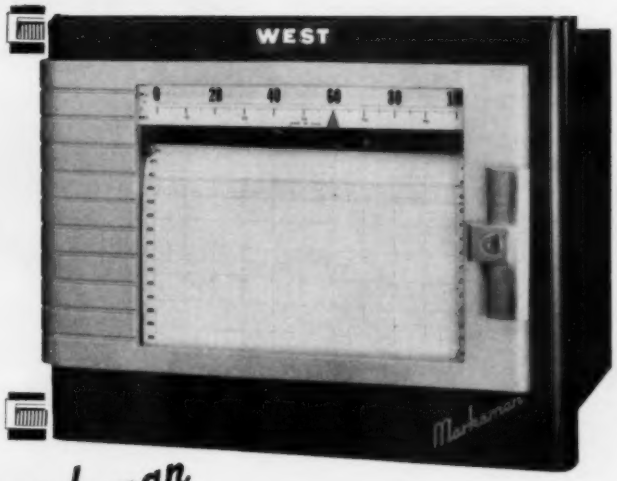
SIX
GREENLEE'S
ON THIS TEAM
GREENLEE
GREENLEE
GREENLEE
GREENLEE
GREENLEE
GREENLEE
Leading Auto Manufacturer Selects
6 Greenlee Transfer Machines For
V-8 Engine Block Precision Machining Line
The entire installation has 127 stations and a machined block comes off the line at each cycle. This first unit drills and reams locating holes, mills main bearings to width, mills lock slots, oil seal and slinger grooves, fuel pump and filter pads and rough bores cylinders. It also has a gauging station to check locating holes, a reject station and three turnover stations, the last of which positions the block for the next machine.
WRITE FOR
COMPLETE INFORMATION
GREENLEE
BROS. & CO.
2085 MASON AVENUE
ROCKFORD, ILLINOIS

SONIC SIFTER manufactured by United Specialties Co. of Illinois is capable of separating particles varying from ½ inch in diameter to as fine as 30 microns (425 mesh) from material passing across a screen. The eight square boxes contain electromagnets which create a violent vibratory action on the screen mesh below. Through harmonics, a basic oscillation of 120 cps can be built up to more than 6000 cps. The mesh of the screen is agitated directly while the frame and support holding the screen are held stationary. The sonic sifter uses one-third the power and handles up to five times the capacity of mechanically activated sifting devices.

---

is extremely resistant to corrosive atmospheres. Available as a cladding on one or both sides of a steel base, as an inlay in the base, or as a strip on the edge of the base, the new material is supplied by American Silver Co. Inc. . . . *Miniature transformers* for use in transistor circuit applications are available for interstage, driver, and output service. Design and assembly assure maximum frequency response and power transfer. Standard line and models to fit special applications are manufactured by James Vibrapowr Co. . . . *Improved weld screws* threaded to ASA Class 2A standards are designed to assure stronger, neater fastenings of projection welded assemblies. The new screws have a protective rim around the periphery of the screw head and four weld projections. The rim limits the amount of pressure that may be applied to the projections during the fusing stage so that the weld material is confined and diffused. Available with projections on top or on the underside of the head, the weld screws are manufactured by Parker-Kalon Div., General American Transportation Corp. . . . *Kit for breadboarding servo systems* contains 262 parts. Unit includes

how many?



Marksman **RECORDERS by WEST**

Now in full production, these completely new tubeless potentiometer strip chart recorders are ready to go to work for you.

Get these features in all standard models at no extra cost:

- Transistorized Amplifier
- Printed Circuits
- Dial 5 Chart Speeds
- Chart Tearoff Strip
- Automatic Standardization
- Standardizing Indicating Light
- Built-in Chart Saver
- Plug-in Construction
- Separate Chart Re-Roll Motor
- Infinite Resolution Slide Wire
- Eleven Inch Calibrated Chart Width
- Will Mount in 19 Inch Relay Rack

Yours are ready! For data or demonstration, write for Bulletin M or phone your West representative listed in the Yellow Pages.

WEST *Instrument* **CORPORATION**
SALES OFFICES IN PRINCIPAL CITIES
FACTORY AND GENERAL OFFICES:
4355D W. MONTROSE, CHICAGO 41, ILL.
BRITISH SUBSIDIARY
WEST INSTRUMENT, LTD.
52 Rugent St., Brighton 1, Sussex
Represented in Canada By Upton, Bradeen & James

the trend is to **WEST**

Circle 670 on Page 165

Visit us in BOOTH 426
4th International Automation Exposition
June 9 thru 13, 1958, in New York

WHAT A DIFFERENCE

● MODULAR DESIGN . . .

Meter switch units are standardized for lower cost and self-contained for quick interchangeability. *Result* — lower gage price, gage downtime virtually eliminated.

This Air-Electric Gage can simultaneously check 11 separate crankshaft dimensions at a rate of 800 per hour (8800 measurements!).

There isn't a production line gage in use that doesn't need care and service. Good design keeps this to a practical minimum. However, few, if any, designs have been aimed deliberately at reducing the amount of time needed to effect service or replacement . . . a critical consideration in production costs. But Federal's MODULAR design arranges construction so that gage downtime is reduced to moments. Only four screws, two finger-tight air hose connections and an electrical connector are involved in replacement of one meter unit by another. Then the replaced unit can be serviced at the bench when convenient. And, with Federal's one-master air system, setting the replacement unit takes only *10 seconds*. Even though the overall gage design is special to suit the particular requirements, these MODULAR units are standardized, which means lower first cost.

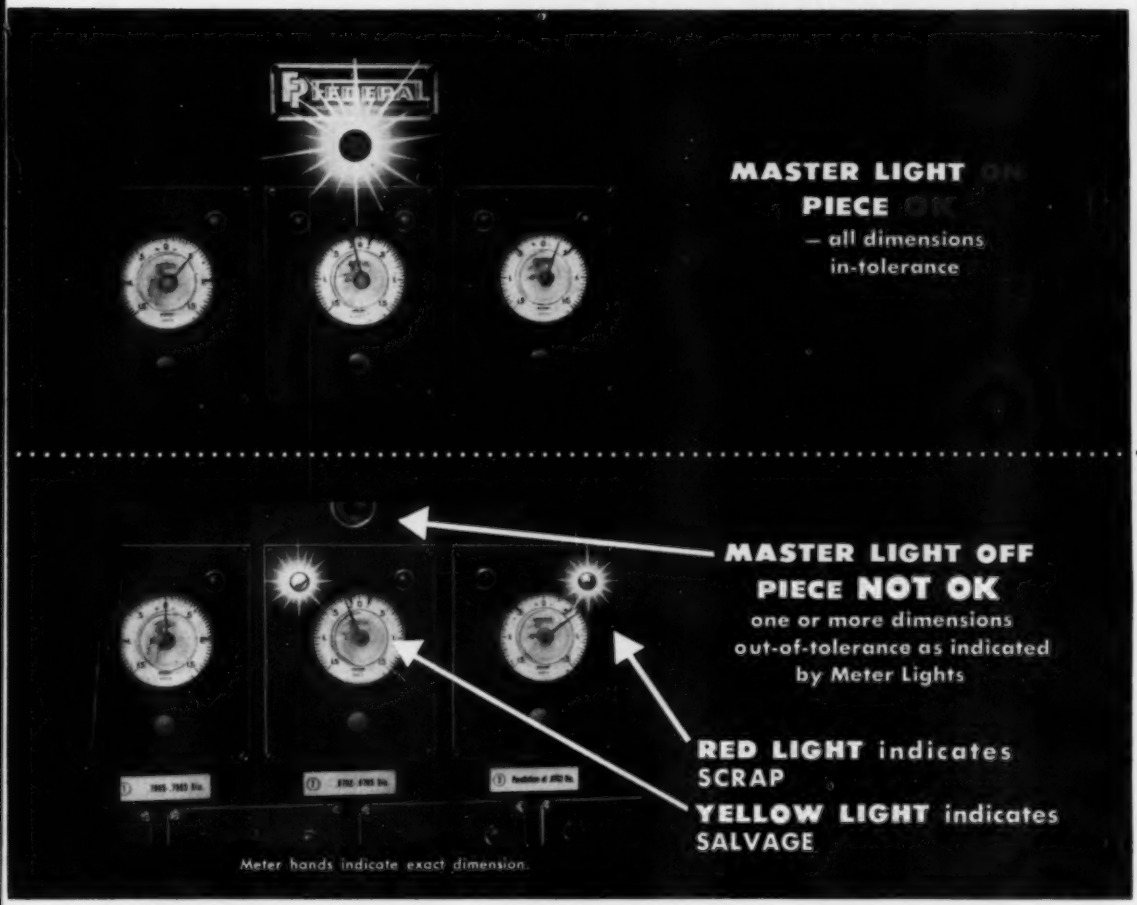
Get in touch with your Federal representative and investigate MODULAR design further . . . in terms of your own needs.

FEDERAL PRODUCTS CORPORATION
8395 Eddy Street, Providence 1, R. I.

IN GAGING ECONOMY!

● MASTER LIGHT CONCEPT...

Lets gage's accuracy, rather than operator's judgment, determine piece acceptability. *Result* — gaging speed doubled, errors eliminated.


MASTER LIGHT ON
PIECE OK
— all dimensions in-tolerance
MASTER LIGHT OFF
PIECE NOT OK
one or more dimensions out-of-tolerance as indicated by Meter Lights
RED LIGHT indicates SCRAP
YELLOW LIGHT indicates SALVAGE
Meter hands indicate exact dimension.

Ordinarily, a multiple dimension gage requires the operator to determine—from scanning a row of bobbins or meters—the dimensional conformance of the piece being gaged. To keep up with the production pace, this must be done quickly . . . often leading to errors, especially in borderline decisions. Also, the fatigue factor in this type of gaging is high, accounting for additional inspection errors.

But Federal's MASTER LIGHT concept eliminates these errors by making acceptability decisions for the operator . . . without hesitation . . . without prejudice . . . without fatigue . . . *without error.* It does more than that, actually. If one or more of the dimensions are "out", the gage spots these and tells the operator instantly whether the piece must be scrapped or whether it can be reworked. Small wonder that this method can increase gaging speed over 100% . . . an increase that can easily mean needing only one gage-operator combination, instead of two, in order to keep pace with production needs.

Another advance that means more economy when you do business with Federal. Talk it over with your Federal representative soon.

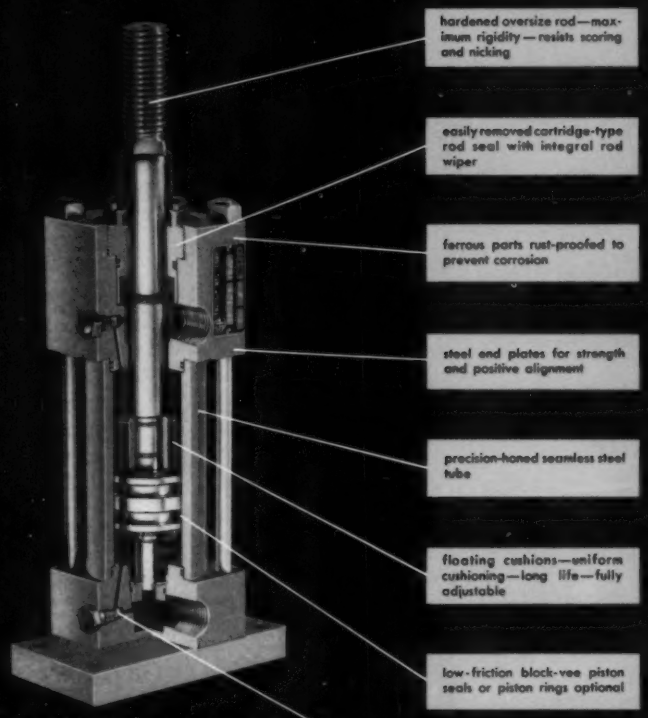
Ask **FEDERAL** *First*

FOR RECOMMENDATIONS IN MODERN GAGES . . .

Dial Indicating, Air, Electric, or Electronic — for Inspecting, Measuring, Sorting, or Automation Gaging

for performance...
dependability...
economy... specify SP

HEAVY DUTY AIR and HYDRAULIC CYLINDERS


hardened oversize rod—maximum rigidity—resists scoring and nicking
easily removed cartridge-type rod seal with integral rod wiper
ferrous parts rust-proofed to prevent corrosion
steel end plates for strength and positive alignment
precision-honed seamless steel tube
floating cushions—uniform cushioning—long life—fully adjustable
low-friction block-vee piston seals or piston rings optional
springless ball checks for faster action

Rated 200 psi air or 1,000 psi hydraulic—interchangeable air or hydraulic without modification—built to JIC standards—specified by automotive manufacturers—conforms to Ford and Chrysler standards.

If your service requirements are severe . . . if you need uniform operation, long trouble-free life, minimum equipment downtime . . . you need S-P heavy-duty air and hydraulic cylinders!

Want more proof? A phone call will bring our representative on the run! Prompt deliveries, too. The S-P Manufacturing Corporation, 30201 Aurora Road, Solon, Ohio.

SP for speed and performance

Representatives in principal cities. Phone or write for Catalog No. 115.

Find us fast in the 'Yellow Pages'

NON-ROTATING AIR AND HYDRAULIC CYLINDERS • ROTATING AIR AND HYDRAULIC CYLINDERS • POWER CHUCKS • COLLET AND DRILL PRESS CHUCKS • VALVES ACCESSORIES

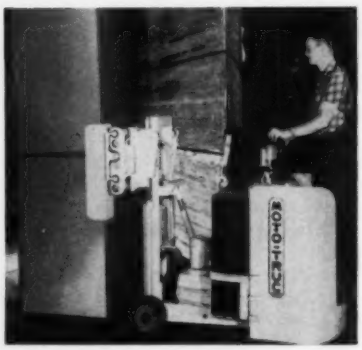
A BASSETT COMPANY • IN GREATER CLEVELAND • ESTABLISHED 1916

AA-7481

two grid plates, grid plate hardware, component and shaft hangers, adapters, electric limit stops, gears, couplings, dial assemblies, and other parts. Kit is packaged in an attractive box provided with cutout shelves and individual cartons for protection of parts and is available from Helipot Corp.

SPOTLIGHTING PLANTS

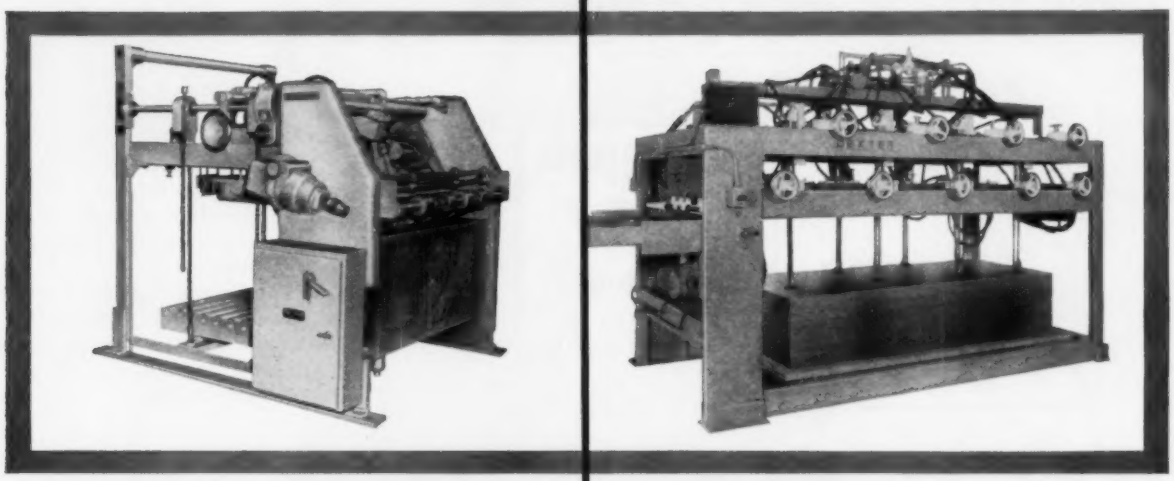
Buhr Machine Tool Co. has completed a major plant expansion which increases its production capacity by approximately 75 per cent. The expansion involved two main bays—one devoted to heavy machining and the other to assembly of multiple-operation machines. Provided by the expansion is a large planer-mill designed for production of standard bases, columns, and other components for building block type machines. . . . **Westinghouse Electric Corp.** has established a new applied research laboratory for the development of new electronic devices. Located in Baltimore, the new laboratory will develop advanced types of electronic tubes, solid state devices, microwave tubes, and information storage tubes. . . . **Cutler-Hammer Inc.** has announced an agreement providing for the acquisition of the assets and business of Airborne Instruments Laboratory Inc. The proposal is subject to the approval of the stockholders



CARTON clamp has been introduced by Moto-Truc Co. for use on the company's line of walkie and counterbalanced industrial trucks. Clamp arms are short and thin and facilitate close order stacking and maneuvering of cartons in confined areas. Side shifting feature permits moving loads sideways for accurate positioning. The clamp is operated by a pair of double-acting hydraulic cylinders supplied by the same pump used to power the tilt and lift mechanism of the truck.

NEED HELP WITH

Sheet Handling Problems?



Dexter 9000# H.D. Feeder runs at speeds up to 9000 sheets of tin plate per hour. Used primarily in most major metal decorating plants.

Dexter Plate Feeder handles metal plates up to 3/16" thick and a maximum size of 4-by-12 feet. Used in many plants for feeding descaling equipment.

CHECK WITH DEXTER

Dexter's been designing and building sheet handling equipment for over 75 years...*sheet feeders* for metal decorating presses, scroll shears, punch presses, coaters, slitters...*pack turnovers* for speeding up two operation processes...*oven strippers* and *pilers*...*cardboard* and *corrugated board feeders* for presses and packaging lines ...*paper feeders* for printing presses, varnishers and folding machines. For almost any sheet feeding problem Dexter has the answer...with its wide range of equipment.

Dexter Feeders are available in over a hundred sizes, speeds and load capacities to suit individual machine or process requirements. Sheet sizes range from 14 x 14" to four by twelve feet...sheet thickness from .006" to 3/16" or more...load capacities from 6,000 to 30,000 pounds ...and speeds from 600 to 9000 per hour!

Thousands of Dexter sheet handling machines are in use today in container plants, electrical equipment factories, appliance manufacturing plants, in tin plating lines, printing and binding companies, and in a wide variety of other industries...speeding up production efficiently and economically.

If you need help with your sheet feeding problems—check with Dexter. Their combination of engineering experience and equipment flexibility may be the solution for increasing your productivity.

Write or call for complete details.

DEXTER
FOLDER COMPANY
DIVISION OF MIEHLE-GOSS-DEXTER, INC.

General Offices: 219 East 44th Street, New York 17, New York

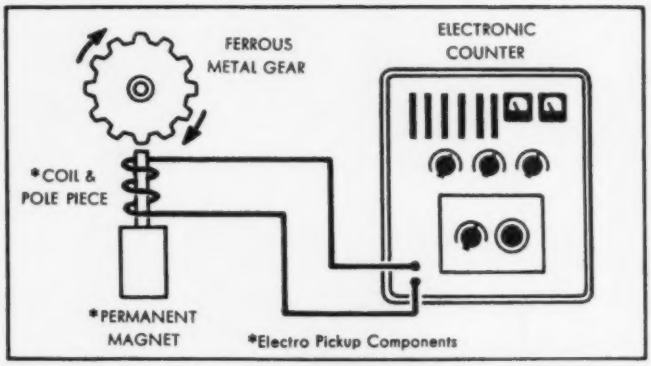
Circle 673 on Page 165

Ideas for your Engineering File

Electro ELECTRONIC EQUIPMENT

MAGNETIC TRANSDUCERS

A precise way to solve your speed measurement problems...



PROBLEM: to measure turbine speeds up to 100,000 rpm

SOLUTION:

a Locate Magnetic Pickup adjacent to the teeth of any convenient gear used in the machine—or add a small bit of magnetic material to a non-magnetic rotor.

b Feed output of Magnetic Pickup directly to electronic counter. Set counter to count for a suitable time—such as 1 second (1/60 minute).

$$RPM = \frac{\text{Displayed count} \div \text{pulses per rev. (no. of teeth)}}{\text{counting time (minutes)}}$$

Accuracy depends on three factors:

1 Accuracy of the counter (usually ± 1 digit).

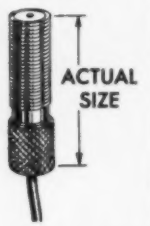
2 Length of counting time.

3 Number of pulses per revolution.

Example:

60 tooth gear providing 60 pulses per revolution with a count of 1 sec. (1/60 min.) will produce an accuracy of ± 1 rpm at *any* speed. (counter reads rpm directly with this set-up). If counting time is increased to 10 sec., accuracy will be ± 1/10 rpm.

Sub-Miniature 3055



¼"-40 Mounting Threads
0.14 oz.

Use to Actuate, Provide Telemetering Data, Indicate, Control, Synchronize

Electronic counters
Relays
Missiles
Motion
Speed
Vibration
Torque
Electric devices
Mechanical operations
Others

8059

ELECTRO PRODUCTS LABORATORIES
4501-U Ravenswood, Chicago 40, Ill., LOngbeach 1-1707
Canada: Atlas Radio Ltd., Toronto

Electro ELECTRONIC EQUIPMENT

Sensing Elements for Control
Counting
Speed and Displacement Measurements

Circle 674 on Page 165

of both corporations. Airborne Instruments specializes in the application of electronics to radar, microwave, and data processing equipment for the military and industry. . . . **Control Systems Co.** is the name of a new company established by Hancock Industries. The new company will develop, design, and market phases of an electromechanical control and monitoring system, applicable to product manufacturing within most industries. . . . **Ramo-Wooldridge Corp.** has changed the name of its Electronic Instrumentation Div. to Electronic Instrumentation Co. . . . **Office Dynamics Corp.** has been recently formed to manufacture a series of business machines. The first unit to be released by the new company will be a new type office machine combining all mailing operations of folding, nesting, inserting, sealing, postage application, and stacking.

MEETINGS AND EVENTS

May 6-8—

Western Joint Computer Conference. Meeting cosponsored by IRE, AIEE, and Association for Computing Machinery to be held at Ambassador Hotel, Los Angeles. Additional information is available from David Parry, 6363 Wilshire Blvd., Los Angeles 48, Calif.

May 7-17—

United States World Trade Fair. Exposition of industrial and consumer commodities to be held at the Coliseum, New York. Further information is available from U. S. World Trade Fair, 331 Madison Ave., New York 17, N. Y.

May 8-10—

American Material Handling Society. Western Material Handling Show sponsored by the Los Angeles Chapter of AMHS to be held at the Great Western Exhibit Center, Los Angeles. Additional information is available from Joe Druliner, 2807 Sunset Blvd., Los Angeles 26, Calif.

May 12-14—

Instrument Society of America. Annual Symposium of the Analysis Instrumentation Div. to be held at Shamrock Hilton Hotel, Houston,

DRILLED 56,000,000 HOLES SAVED $140,000

that's automation with ARO PAR-A-MATIC DRILLS at progressive Michigan firm!

Running two years, ARO Par-A-matics have drilled 56 million holes in compressor pistons *without trouble* at a growing Michigan company.

Hole sizes: 1/16", 1/8". *Pistons drilled:* 7,000,000.
Savings: 2¢ direct labor per piston.

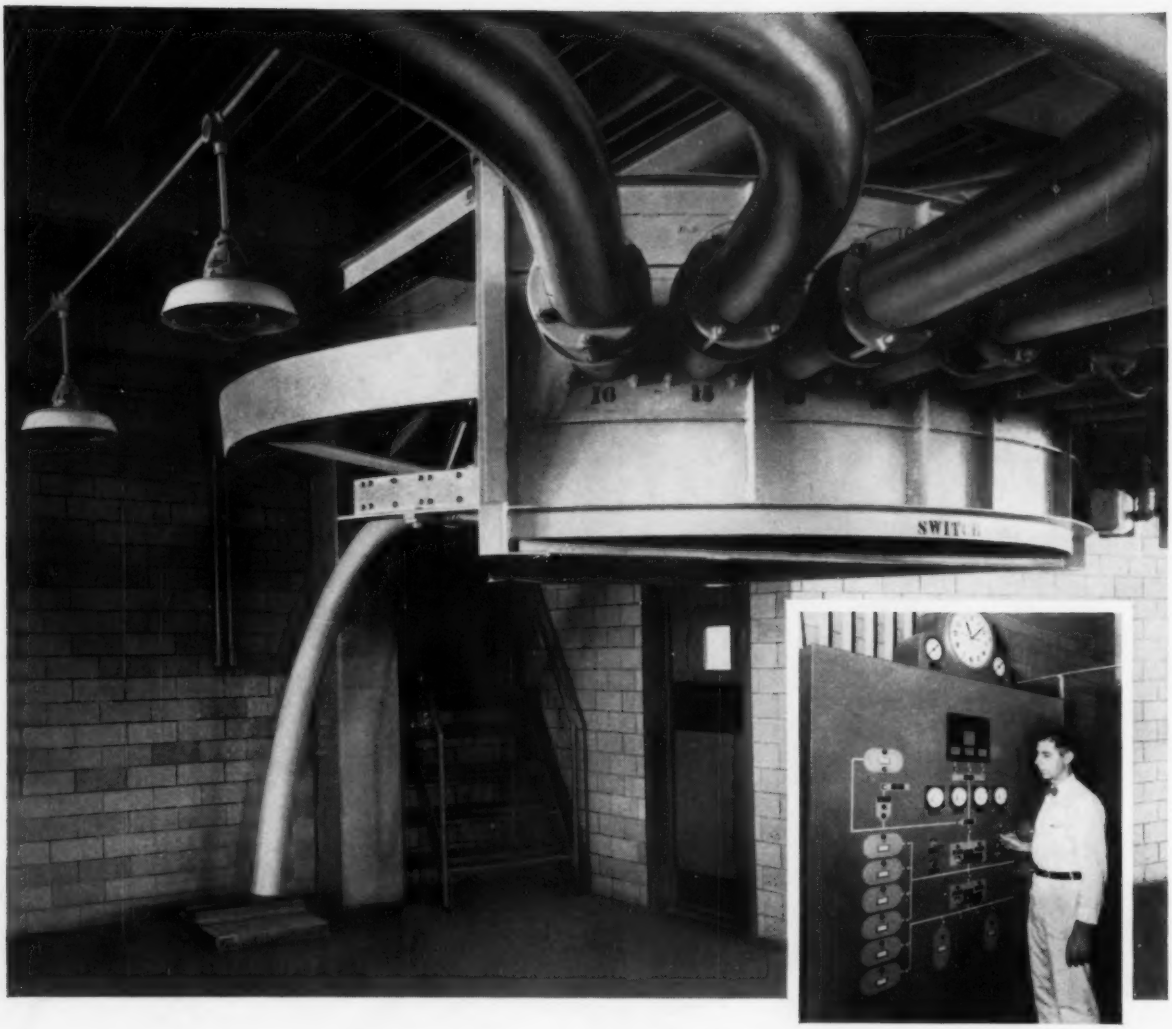
★ *See this set-up in action at our Booth 1810 A.S.T.E. Show*

Let ARO Field Engineers help you automate your drilling with multiple Par-A-matic installations. Drill any number of holes at a time. Simple set-up . . . air-operated . . . adjustable stroke length . . . variable rate of feed. Write for bulletin 5546-T.

THE ARO EQUIPMENT CORPORATION
Bryan, Ohio
Aro Equipment of Canada, Ltd., Toronto 15, Ont.
Offices in All Principal Cities

ARO® AIR TOOLS
Also Air Hoists . . . Automation Tools . . . Paint Pumps . . . Material Handling Pumps . . . Industrial Lube Equipment

Circle 675 on Page 165



MILLIONS OF POUNDS—FROM AIRSLIDE® CARS TO MIXERS

. . . Conveyed Pneumatically

The most modern system for automatic unloading, storage, proportioning of ingredients, and transport to mixers in the food industry is saving time and money for a large eastern bakery.

The system is operated by two men who receive, store, proportion, and deliver to mixers 10 million lbs. of ingredients a month.

Fuller equipment for this operation includes: a vacuum type Airveyor® system with three bulk flour unloading stations, a pressure type Airveyor system for transferring flour to storage or sugar from storage to icing department, and two specially designed motorized pipe switches through which the various flours are diverted to selected bins. F-H Airslides and metering feeders are located at the bottom of the storage bins.

Not only has this pneumatic system resulted in substantial savings for the bakery, but it has also established sanitary conditions and conserved storage space.

For speed, convenience, and sanitation in *your* materials handling operations, call on Fuller. The proper combination of Airveyors, Airslides, and accessory equipment to meet your specific handling requirements will increase material flow, release workers for higher skills, modernize your production methods.

Write today for helpful information, and unbiased materials handling service. A-252 4279

Visit us at the Materials Handling Show—Booth No. 613-615.

FULLER COMPANY

162 Bridge St., Catasauqua, Pa.

SUBSIDIARY OF GENERAL AMERICAN TRANSPORTATION CORPORATION

Birmingham • Chicago • Kansas City • Los Angeles • San Francisco • Seattle

Fuller

. . . . pioneers in harnessing AIR

FULLER COMPANY GENERAL

Circle 676 on Page 165

MEMORY METER that retains indefinitely a reading taken at any desired instant has been developed by Assembly Products Inc. The unit is especially suitable where readings cannot be noted immediately. A normally energized solenoid mounted on the rear of the meter is de-energized when a reading is desired. A nylon-headed plunger on the solenoid pushes against the back of the meter face which is normally held away from the pointer by two small springs. The pointer is held fast at the instant of reading between the meter face and a clamper plate mounted over the top arc of the meter face. After reading, the solenoid is energized to permit free movement of the pointer.

Tex. Further information is available from H. S. Kindler, ISA Director of Technical Programs, 313 Sixth Ave., Pittsburgh, Pa.

May 25-28—

National Office Management Association. 39th International NOMA Conference, and National Office Machinery and Equipment Exposition to be held at the Conrad Hilton Hotel, Chicago. Additional information is available from Denham & Co., 925 Book Bldg., Detroit 26, Mich.

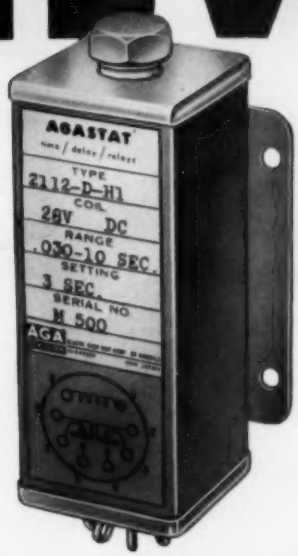
May 26-29—

American Management Association. National Packaging Exposition to be held at the Coliseum, New York. National Packaging Conference to be held concurrently at Hotel Statler, New York. Additional information is available from Donald G. Keen, Press Relations Director, 1515 Broadway, New York 36, N. Y.

May 27-28—

Electronic Industries Association. Conference on maintainability of electronic equipment to be held at the University of Pennsylvania, Philadelphia. Further information

NEW



MINIATURE AGASTAT®

time delay relay

for . . . missile, aircraft and electronic applications

INSTANTANEOUS RECYCLING . . . reset time—less than .020 seconds

UNAFFECTED BY VOLTAGE VARIATIONS . . . time delay remains constant from 18 to 30 volts DC

ADJUSTABLE . . . time delays from .030 to 120 seconds

CHOICE OF OPERATION . . . for either energizing or de-energizing

SMALL . . . height—4⅝" . . . width—1-13/16" . . . depth—1½"

LIGHT . . . maximum weight—15 ounces

MEETS ENVIRONMENTAL REQUIREMENTS OF MIL-E-5272A

This new AGASTAT time delay relay is an externally adjustable, double-pole, double-throw unit. It incorporates the basic AGASTAT timing principle, proved by a half-century of reliable operation on automatic aids to navigation, in a space-saving miniature unit, built to withstand the rugged environmental conditions of missile and aircraft applications.

For specific information on the new AGASTAT relay for your application, write to Dept. A29-523.

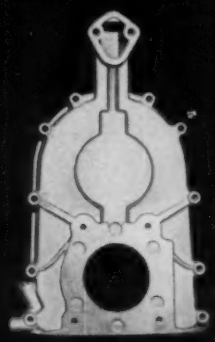
AGA DIVISION **ELASTIC STOP NUT CORPORATION OF AMERICA**

1027 Newark Avenue, Elizabeth, New Jersey

Pioneers in pneumatic timing

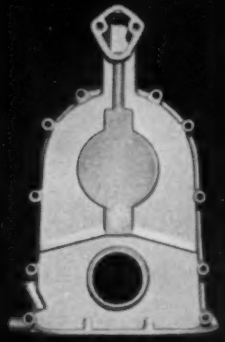
Circle 677 on Page 165

Power Steering Cover



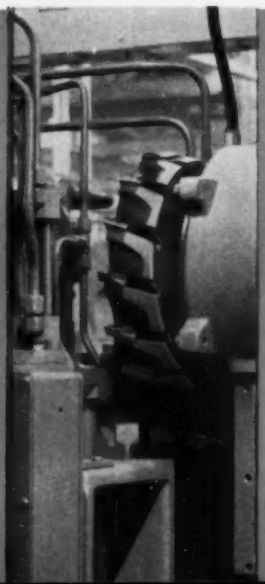
LOAD THESE TWO PARTS AT RANDOM

Conventional Steering Cover



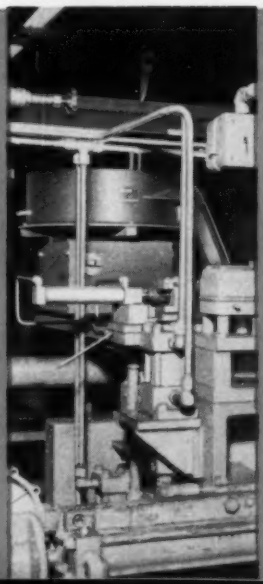
This Natco selects the cycle automatically– machines 200 parts per hour, regardless of mix

One of the two stations where milling operations are performed (machine guard-rail removed).



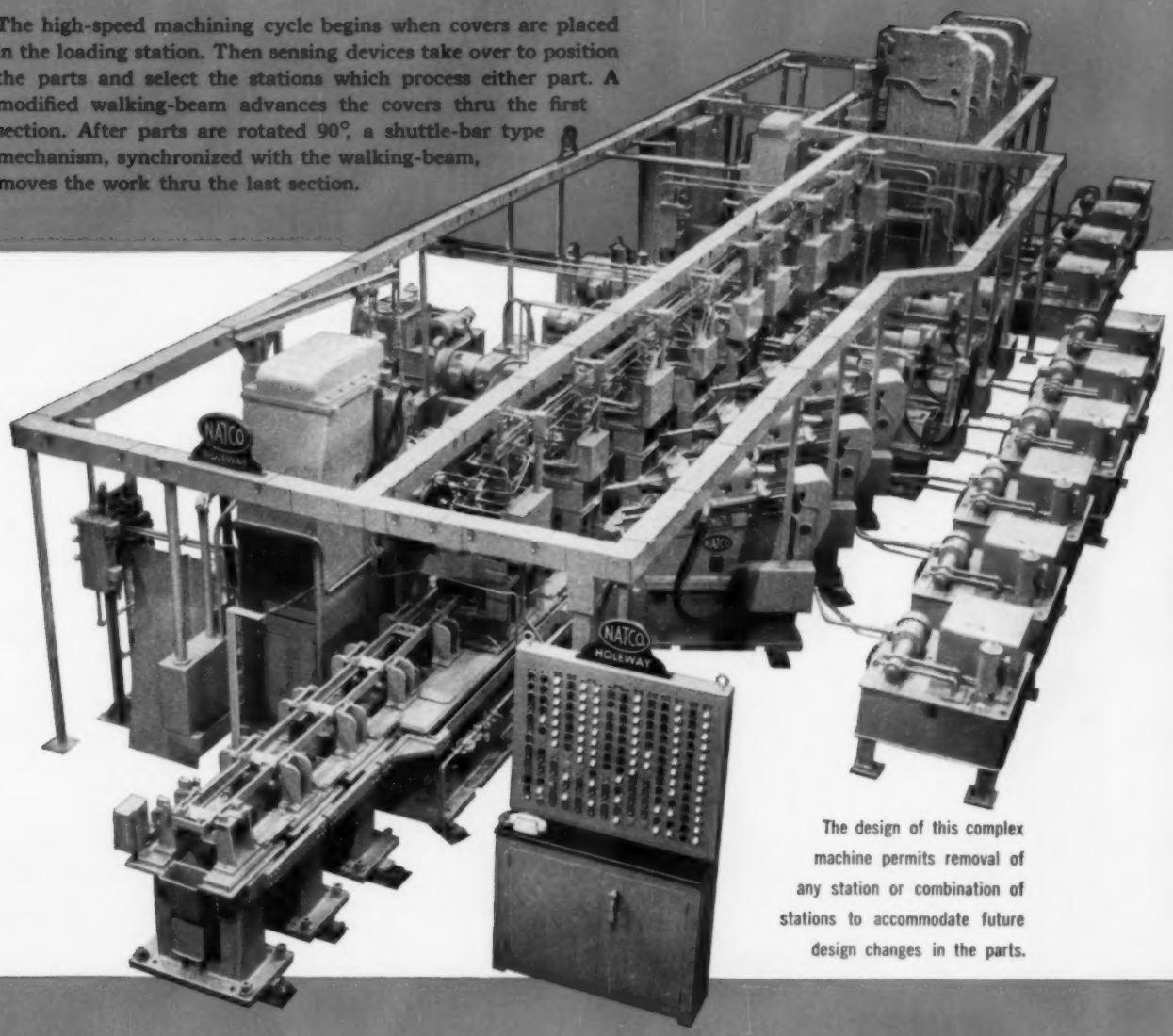
Communication with the main control pulpit can be obtained from phone jacks along the entire 68-foot machine.

A vibratory feeder delivers Welch plugs which are inserted in the necks as the covers reach final processing stages.



This 32-station NATCO Transfer and Assembly Machine is part of the automated production-line on which engines are built at a major automotive plant. The NATCO performs selectively a number of unusual processing operations in the work cycle, including milling, deep-hole drilling, Welch-plug assembling, and probing.

The high-speed machining cycle begins when covers are placed in the loading station. Then sensing devices take over to position the parts and select the stations which process either part. A modified walking-beam advances the covers thru the first section. After parts are rotated 90°, a shuttle-bar type mechanism, synchronized with the walking-beam, moves the work thru the last section.



The design of this complex machine permits removal of any station or combination of stations to accommodate future design changes in the parts.

This Transfer and Assembly Machine is one of a large number of NATCOs which perform many types of complex processing operations in all kinds of manufacturing plants. A NATCO field engineer will furnish you with detailed information; a phone call may save you valuable processing time.

NATCO

National Automatic Tool Company, Inc.

Richmond, Indiana ***Multi-spindle drilling, boring and tapping machines. Special machines for automatic production. Call Natco Offices in Chicago, Detroit, New York, Buffalo, Philadelphia, Cleveland, Los Angeles; distributors in other cities.***

Circle 678 on Page 165

1.

2.

3.

4.

New shipping box for battery acid... Corrosive liquids ship safely, economically in easy-to-handle polyethylene bottle and H & D corrugated box. Lightweight unit fills and dispenses quickly without opening box. For your packaging problem, better see H & D.

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June 9-12—

American Society of Mechanical Engineers. National conference on materials handling to be held in conjunction with the National Materials Handling Exposition at the Public Auditorium, Cleveland. Additional information is available from Banner & Greif, 369 Lexington Ave., New York 17, N. Y.

June 9-13—

International Automation Exposition. Fourth International Automation Congress and Exposition to be held at the Coliseum, New York. The First Military Automation Exposition will be held at the same time and place. For additional information, contact Harrison Gilmer, Richard Rimbach Associates Inc., 845-A Ridge Ave., Pittsburgh 12, Pa.

June 12-14—

American Institute of Industrial Engineers. Ninth Annual National Conference and Convention to be held at Hotel Statler, Los Angeles. Additional information is available from S. J. Ross, Publicity Chairman, 329 E. Green St., Pasadena, Calif.

June 15-19—

American Society of Mechanical Engineers. Semiannual Meeting to be held at Statler Hotel, Detroit. Additional information is available from ASME headquarters, 29 W. 39th St., New York 18, N. Y.

"Contract called for debugging the machine before shipment."

Circle 679 on Page 165

Circle 680 on Page 165→

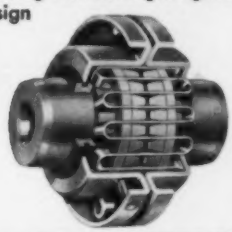
How one FALK coupling saved more than $1,000 per month

Pictured below is a Falk Steelflex Coupling assembly which connects a 2500 hp motor to a reduction unit driving an 18″ bar mill in a Midwestern steel plant. This coupling replaced another type which broke repeatedly, causing maintenance expense averaging $1,000 a month—plus costly production losses. Since installation of the Falk Coupling, with its controlled torque mechanism that disengages when a predetermined overload occurs, there has been no interruption of production. Savings in maintenance and in lost production time are well in excess of $1,000 per month...dramatic proof of the importance of coupling design!

Long coupling life is not the sole criterion of coupling performance. Inadequate shaft couplings may be the cause of bearing damage or shaft breakage on your machines. If so, a change to Falk Steelflex will give twofold protection to your connected machines: (1) compensation for reasonable degrees of shaft misalignment, and (2) torsional resiliency to reduce peak loads as much as 30%. These advantages are as important to you as the long service life of the Falk Steelflex Coupling itself.

Falk Steelflex Couplings, in types and sizes to meet virtually all industrial applications, are promptly available from distributor, warehouse and factory stocks. Consult your Falk Representative or Authorized Falk Distributor.

Basic **Type F**—cutaway view showing exclusive grid-groove design



THE FALK STEELFLEX ...a truly flexible coupling

Here is the coupling that has all the strength of steel, yet is truly flexible. *More than a million* have been bought for industrial service of many kinds.

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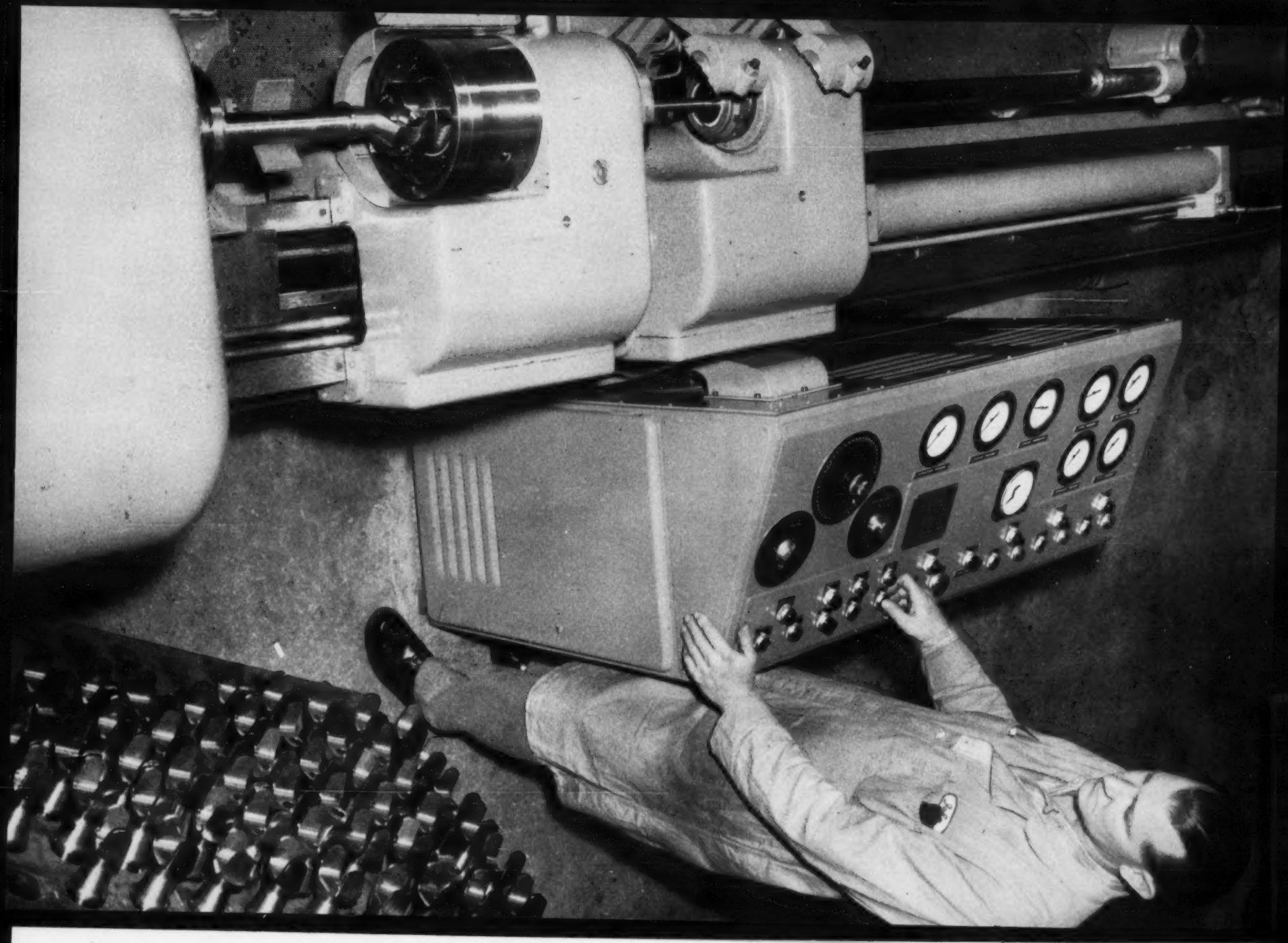
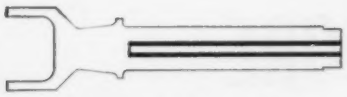
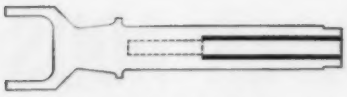
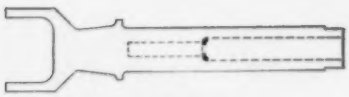




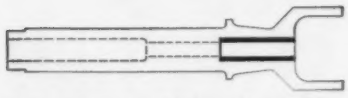
1. Solid bore—feed 5¾" per minute.



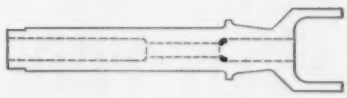
2. Counter bore—feed 8" per minute.



3. Form radius—feed 5¾" per minute.



4. Reverse part, solid bore—feed 5¾" per minute.



5. Form radius—feed 5¾" per minute.

6. Part finished accurate to ± .001" on length and concentricity, 25 to 30 micro-inches on finish! Part is forging, length 14¼", 4130 steel, Rockwell 39 to 43-C.

This horizontal pin machined

8 TIMES FASTER . . .

on the Rapid Borer

Formerly, this aircraft part was rough drilled, reamed, radius formed, ground and honed. Operation called for turret lathe, grinder and honing machine. Even with experienced operators, incidence of spoilage was high because of precision requirements.

On the LeBlond-Carlstedt Rapid Borer, there is only one set-up. Part is completed, *finish bored* in 5 simple operations. Cycling is automatic. Workpiece spoilage is down. Operation is so simple that unskilled operators are quickly trained. Currently 2 different sizes are being produced in lots of 300 to 400.

LeBlond-Carlstedt Rapid Borers will solid bore, trepan or counterbore holes 3 to 8 times faster than by the conventional D-bit method! Hole capacity from 5/16" to 4¼" diameter. Handles symmetrical work—round, square, octagonal, tapered or stepped—wide variety of hole diameters and depths, work sizes. Available in three sizes, No. 15, No. 30 and No. 60.

Tell us about the holes you'd like to produce faster. Large holes or small. If the Rapid Borer can handle the job, you'll produce them faster than ever before. Write for Bulletin LC 501 P.

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According to Peter J. Salmon, Owner, "*No machinery investment we've ever made has reduced our immediate costs as dramatically as the LeBlond-Carlstedt Rapid Borer. Actually, it competes cost-wise with any other holemaking method for holes as shallow as one inch. On longer holes there's no comparison! Not with the Rapid Borer, which can feed over 30" per minute!*"

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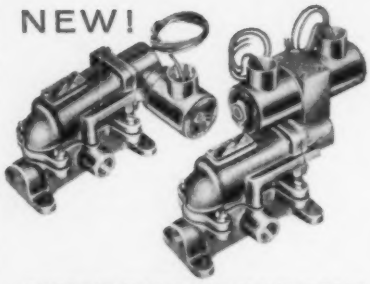
NEW!



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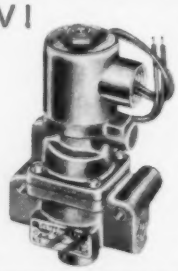
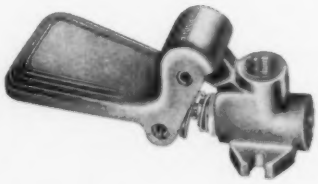


NEW! 3-WAY SOLENOID VALVES—Simple 3-way action available in full series—voltage, port sizes, flow capacities. By shifting pilot chamber head 90°, normally open changes to normally closed, and vice versa!

NEW!



2- AND 3-WAY FOOT VALVES — With right angle ports. Give convenience and control with simplest installation. Mount directly on floor. ⅜" N.P.T. Sturdy, compact, and *versatile*. Take minimum space.

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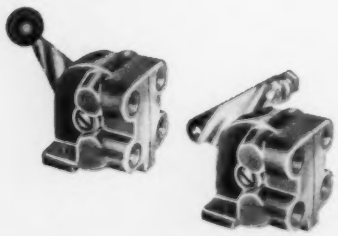

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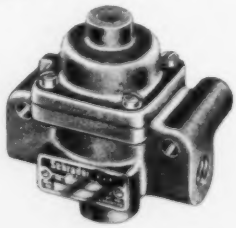

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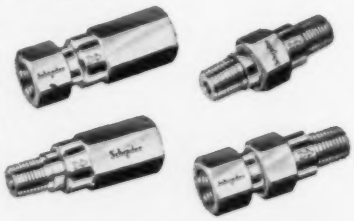

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QUALITY AIR PRODUCTS

Circle 682 on Page 165

By JAMES C. KEEBLER
Managing Editor

Danly Quick Die Change Press has wheeled bolsters. Machine pictured is part of an installation of two complete lines built for SIMCA, European automobile manufacturer.

They Gotta Be Shown

GATHERING in Chicago this year for the National Production Meeting and Forum, the SAE had a cost-conscious aroma about its automation potpourri.

Gamut Runner

The program ran the gamut of automation topics from assembly through numerical control, computers for production, heat treating, quality control, all the way to the "ABC's of Operations Research."

Sign of the times (the dollar sign in crisis) was reflected by words such as: How can the use of automation promote economics and efficiency in assembly operation? Automation—How far should it be carried? Improve quality and cut costs. When does a computer pay off? Numerical control—How much should it cost?

Looking Glass

This reflection was mirrored back by the participants who gave the impression that in the present state of financial affairs the engineers who set up systems for automotive production aren't going to go on record as recommending the purchase of five cents worth of anything unless they are dead sure they're going to get a nickel's worth of value out of it.

Whether this also reflects a state of more mature thinking on the part of the automotive automaters, or whether this is the instinct of self-preservation expressing itself, is an issue we'd best not discuss. (Reduced payrolls can be achieved by terminating production engineers who guess wrong.)

Steel magazine's "Mirrors of Motordom" column gave the engineers the benefit of any doubt (they were discreet enough not to suggest a doubt) by headlining their report of this affair, "Engineers Gain Stature." The first sentence, "Automation engineers are adding a new dimension (economics) to their thinking," sounds the keynote of the report.[1]

The impression is that prior to now (or prior to the recession) the engineer was primarily concerned with the technical feasibility of doing things automatically and would buy any automated pipe dream he could get approved. But this is reported changed. Now slip-stick sliders have become more broad gage in their thinking (or have read the handwriting on the wall) they are awakening to the value of the dollar bill and conscientiously considering "Will automation pay for itself?"

Glass of Rose

Some of us who like to think of *Automation* as *applying automatic operations as the economics of the situation limit or require,* like to feel also that the automation engineer has been cost-conscious from the word go—that no one, but no one, would go automatic just for the thrill of hearing relays hammer, hydraulic systems groan, and air valves hiss.

This attitude may be looking at the industry through rose colored spectacles, however. After all there are two phases: 1. Figure how to do it automatically. 2. Figure whether or not it'll pay off. You can't do Phase 2 until you've done Phase 1 and you might not have much time left to consider Phase 2 after you've solved the problem of Phase 1.

Because equipment cost estimates involve so many unknowns, and payoff calculations include a list of factors as long as your arm (see Pages 52 through 65) it is reasonable to assume that the engineer who has a heartfelt yen to see his pet project in orbit may have previously succumbed to the temptation to put a rosy glow on some of his guesstimated figures. Such shenanigans can cause the totals to point to the green light.

Then too, the press of business pace during good times has often led conscientious management (who know that economics is a complex subject) to fly by the seat of the pants and OK a project even though it has dollar sign question marks on it. MacWilliams[2] notes that evidence of a competent analysis may do more to sell the proposed

[1]References are tabulated at end of article.

Clearing Moving Bolster Press made for North American Aviation includes die separator feature that makes it possible to open dies outside press for maintenance and inspection.

equipment than the actual payoff figure.

To those of our fellow SAE members who have recently joined the ranks of the cost-conscious, we say, "Welcome aboard." To those (if any there be) who have signed up 'cause they're runnin' scared, we say, "Cheer up. When the economic worm turns and customers are no longer hibernating you can go back to taking the risks that have spelled progress since the invention of the pushbutton."

In these times of cost crisis, expansion programs are diminished and most equipment installations are on the basis of payoff. We should learn more about economic analyses because they are popular and companies without orders have more time available to help prospects conjure up a justification. The broader one's thinking, the bigger his Bufferin bill. Don't stop with equipment cost estimating and payoff calculations, but go on to figure economic lot sizes under dynamic business conditions and you'll find that the relative success of your automation program has more ingredients than a fruit cake.

Neklutin[3] took the first derivative de/dx and equated it to zero to get his equation for economic lot size. By actual count the factors in his calculations total 16.

On the Skids

Because the costs of setup and floor space appear in both the payoff and lot size calculations, and because the problem of product storage and capital tied up in inventory enters strongly in the latter, there is timely reason to take note of an automation development whose big pitch is reduced setup time.

Pressmakers have come up with the idea of wheeled bolsters. Although Grandma White might think of a bolster as a pillow that goes clear across the bed, pressmen rest their dies on bolsters in the bottom of draw presses and the cushioning is done by an air cylinder below the bolster. Before the invention of the wheeled bolster it was customary to put the die in the press from the front or back. If the press had loading and unloading equipment on its front and back something had to be cleared away while a die truck and/or a lift truck jockeyed the die into place.

The new look is to have openings in the sides of the press and tracks in the floor. Two bolsters are used. When one job is run off the operator causes the press slide to stop at bottom of stroke—lowers the cushion from under the bolster—unclamps the die from the slide—raises the slide—lifts the bolster off the bed—rolls bolster out of press to the side—rolls other bolster into press—lowers bolster onto bed—sets slide to new shut-height—lowers slide to bottom of stroke—clamps die to slide—raises slide—raises cushion—makes trial run—runs lot. This procedure can be done completely by pushbutton without the operator having to lift a wrench.

By setting up the next die on a bolster beside the press while it is running, the press utilization factor is enhanced. Setup can be by overhead crane and basic between-press handling equipment need not be moved out.

Of real appeal to cost-conscious automaters is the reduction of setup time and cost that will help lower the economic lot size. Big lots of big stampings require big storage facilities that not only tie up capital in inventories but cost big money to rent. The increased production capacity this system provides may save you the cost of a press.

Big pressmakers who have indicated to us that they're offering this kind of equipment include Bliss, Clearing, Danly, Hamilton, Verson, and Warco.

Jake Falstaff probably had the answer when he said that economics can be summed up in eight words: "There ain't no such thing as free lunch." But automakers may find wheeled bolsters a way to save a buck in these days when things are only normal and the economy has lost its boom.

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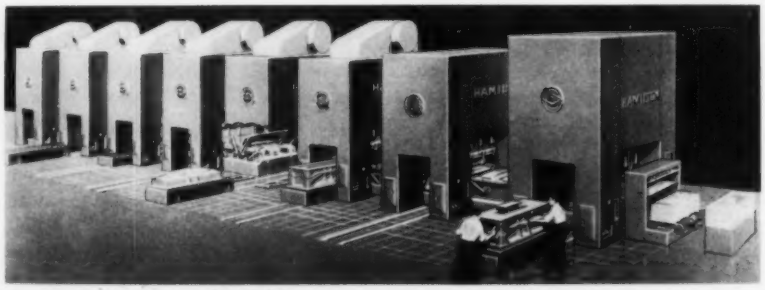
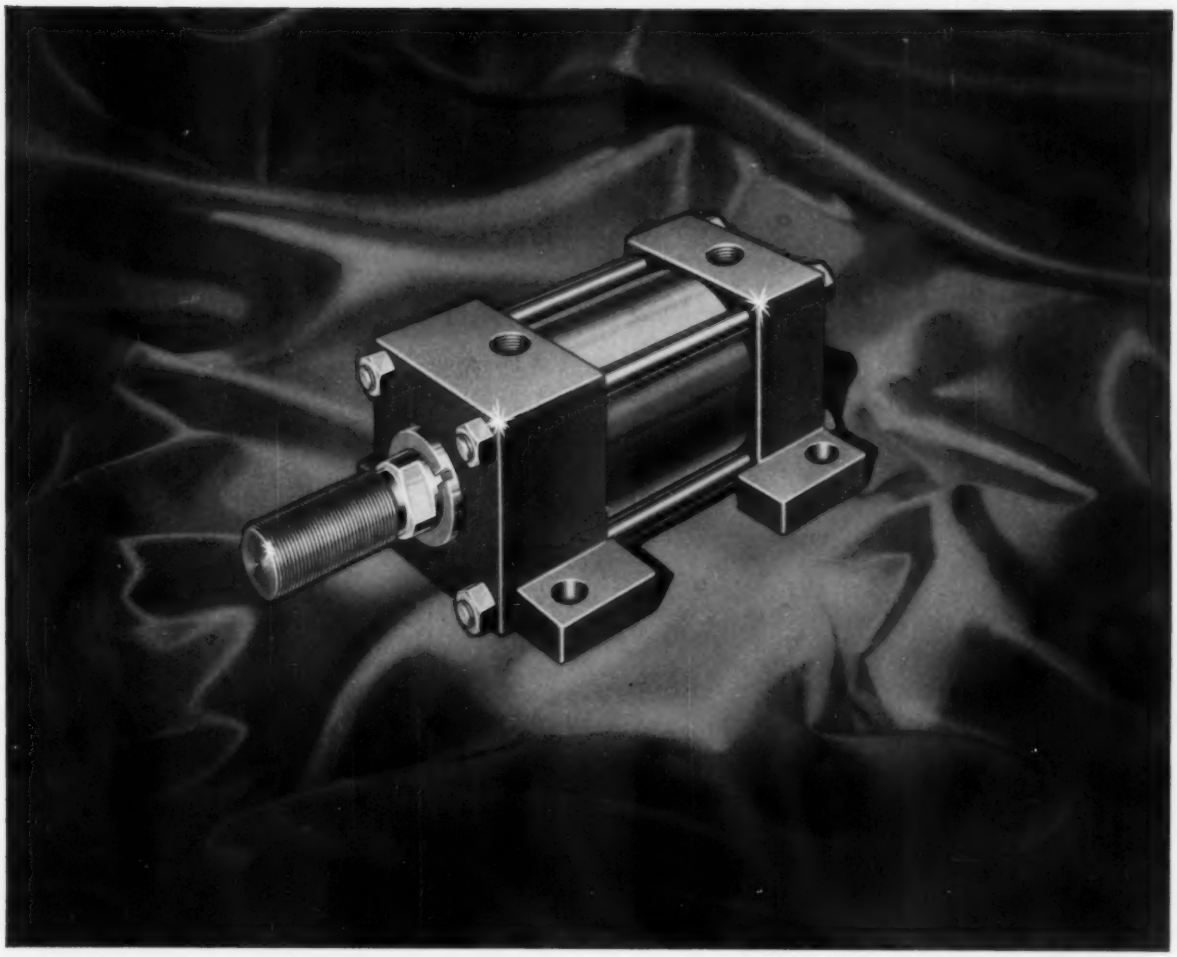
2. R. W. MacWilliams—"How to Figure Payoff," AUTOMATION, Vol. 5—No. 5, May 1958.
3. C. N. Neklutin—"Automation Economics," AUTOMATION, Vol. 4—No. 11, November 1957.



Artist's drawing of line of Hamilton presses equipped with wheeled bolsters. Since dies are not installed from front or back, presses can be closer together.



Illustrated—Logan Super-Matic Cylinder Meets J.I.C. Standards

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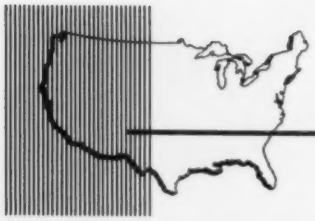
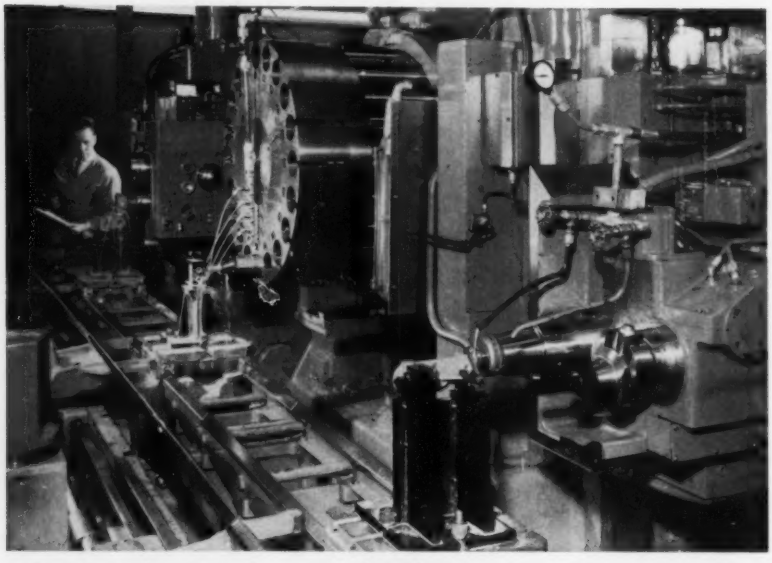
Circle 683 on Page 165



western roundup

By GILBERT C. CLOSE
Hawthorne, Calif.



Prototype of numerically controlled production system developed jointly by Hughes Products (electronic controls) and Kearney & Trecker Corp. (machine tools). Different parts can be automatically machined simultaneously under control of individual punched tapes. Prototype includes (left) milling machine, drilling machine, and two-spindle boring machine. Drilling machine offers a choice of drills and taps from turret containing 20 tools. Spindles on boring machine can be automatically adjusted by electronic controls for different diameter cuts.

There Is A Difference

THE ASSIGNMENT by the Editor to prepare a monthly column for AUTOMATION magazine covering western area developments in automation was at first viewed with considerable misgivings by this writer. These questions required an answer: Why, with the nation as unified as it is today, and with the elements of time and distance reduced to the vanishing point, would automation developments in the West differ from similar developments in the East, North, or South? What would there be to write about that was not being discussed or written about in all other sections of the nation?

After discussing the project at length with several men who have been prominent in the development of automation, this writer began to blush furtively everytime he thought of those early misgivings. His fifteen years of intensive technical journalistic work in the western area had played him false at last. He was caught in the net of that trite but time-tried old adage of "being too near the forest to observe the trees!"

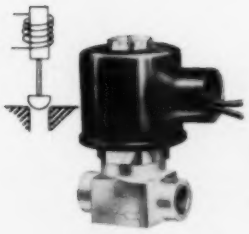
An official in a large airplant, who was and is a pioneer in the development and adaptation of numerically controlled machines, put it this way—"From the engineering standpoint, automation must be viewed objectively. But when discussing the application of automation to industry, a subjective viewpoint is necessary. Many things over and above the availability of automation equipment must be taken into consideration. For instance—is a specific company ready for full-scale automation, or does its prior investment in nonmechanized, unconvertible equipment preclude such an all-out plunge? Can spot or localized automation be used to advantage? Can the products being produced be redesigned to better adapt them to automatic production? Such factors often have more to do with automation developments than the availability of automated equipment itself."

Starting from Scratch

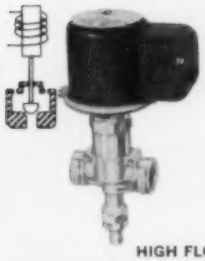
The president of a large company now developing a prototype numerically controlled machine expanded on the peculiar advantages enjoyed by western industry as a whole in the push toward automation. "Western industry is new, and not hamstrung by tradition," he said, "and youth is always more susceptible than age to new ideas and change. Most of our plants are relatively new, and the equipment they contain is new and well worth converting to automatic operation. Most of us in the west are not held back by huge investments in nonmechanized equipment which is outdated and is neither convertible or worth converting to automatic operation, despite the fact it still retains a large book value. Finally, the growth rate of western industry will favor automation. New factories are going up faster than in any other portion of the country, and many of these plants will be automated from the very start."

The manager of a relatively small but well-automated machine shop presented a more brutal, demanding, and realistic side of the picture—"It was automate or else —for us! We, and a lot of shops like us, depend upon the concentration of huge, critical defense industries in the west to supply us with a major portion of our work. Much of this work is such that it can't be produced economically by conventional shop techniques. Unless we automate so that we can produce it quickly, accurately, in suf-

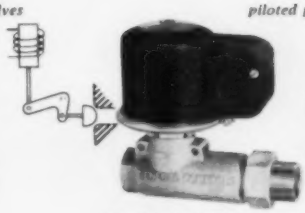
these six basic valves will meet any electric valve requirement you have



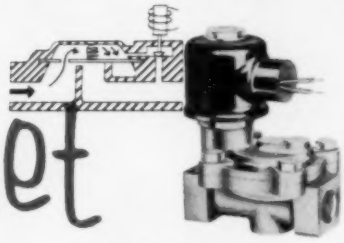
GENERAL PURPOSE
direct acting solenoid valves



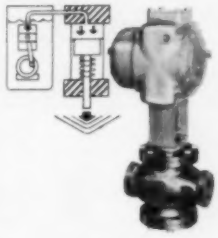
HIGH FLOW
piloted piston solenoid valves



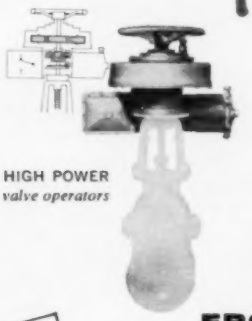
HIGH PRESSURE
lever action solenoid valves



HIGH FLOW
magnetic diaphragm valves



HIGH VOLUME
HIGH PRESSURE
Hydramotor valves



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Circle 684 on Page 165

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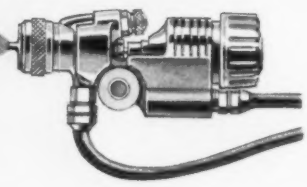
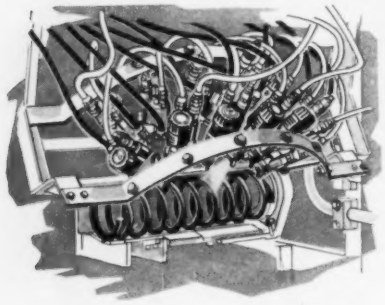
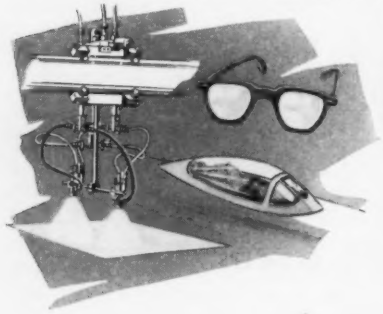


How do you test helical automobile springs to insure softer, smoother rides? An Ohio manufacturer found the answer in designing an Electronic Spring Tester equipped with twelve DeVilbiss automatic spray guns. Each spring fed into this machine is compressed to near maximum or to a predetermined measurement. The stress is transmitted to an electronic selector which actuates one of the automatic guns to color-code each spring according to its strength. Up to 900 springs can be tested in an hour—spray cycling taking less than half a second!



★ ★ ★

Increased demand and new uses for its plastic laminates prompted a leading New Jersey manufacturer to search for a faster, more efficient means to apply laminating adhesives. Uniformity of coating and constant production rates—highly critical in this operation—made precision spraying to close tolerances a must. A DeVilbiss automatic machine solved their problem. Holding a definite film thickness, it coats rows of 9″ x 18″ plastic sheets with adhesive at a speed of 16 feet per minute —or even faster if production warrants it.



★ ★ ★

If any of your operations involve the application of fluids, mastics, paints, or sprayable compounds, a DeVilbiss research engineer will gladly analyze your requirements without obligation, and help you determine if automation will pay off for you. Won't you call or write us? *The DeVilbiss Company, Toledo 1, Ohio; Barrie, Ontario; London, England. Branch offices in principal cities.*

FOR BETTER SERVICE, BUY
DEVILBISS

Circle 685 on Page 165

ficient amount, and at a reasonable cost, these big defense plants will automate and do the work themselves. Western shops which are dependent upon these industries must gear themselves to produce parts and components which were designed without consideration of conventional machine shop limitations. Unless they do this, they may as well close their doors!"

After listening to the above opinions, and many more which substantiated these lines of reasoning, this writer came to the conclusion that he, taking the engineering approach, had been viewing automation too objectively—as a development in itself rather than as an aid to industry and subject to the same limitations to which all industrial developments must bow. The insight to the peculiar advantages enjoyed by western industry as a whole in the change-over to automation, and the revelation that others in the west will be forced to follow the trend or close shop, left little doubt that automation in the western area will blaze and follow its own trail. Following this same trail will be the editorial goal of "Western Roundup."

In Los Angeles . . .

New advances in semiconductors, electron tubes, circuits, automatic controls, and other electronic devices will contribute greatly to the continued progress of American industry in the immediate future, according to Rollin M. Russell, an executive of the Hughes Products Division of Hughes Aircraft Co., the west coast's largest electronic manufacturing firm.

"During the year the electronics industry will be completing development of a variety of controls for automating machine tools and processes," Russell said. "As these are proved, and manufacture on an economical basis is achieved, every segment of industry will be on the way to automation."

Russell predicted the biggest push yet toward automation will get under way during 1959 and 1960.

"The bulk of our 1958 sales—in excess of $30 million—will come from diodes, transistors, rectifiers and other semiconductor devices, but we also anticipate a healthy increase in sales of electron tubes and instruments," Russell said.

Circle 686 on Page 165→

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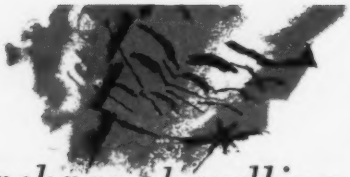
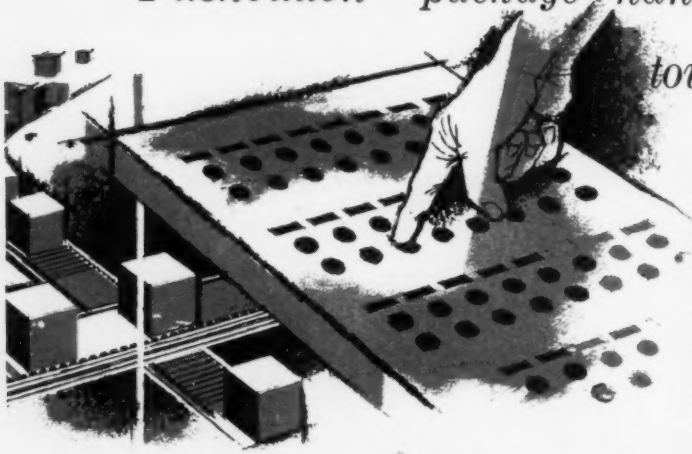


"Pushbutton" package handling points

toward new **PROFITS**



One of your greatest cost-saving opportunities today is in "pushbutton" movement of packaged goods. In industry after industry, Alvey leads the way in engineering new methods that minimize handling, speed work flow and increase profits through automated conveyor systems.

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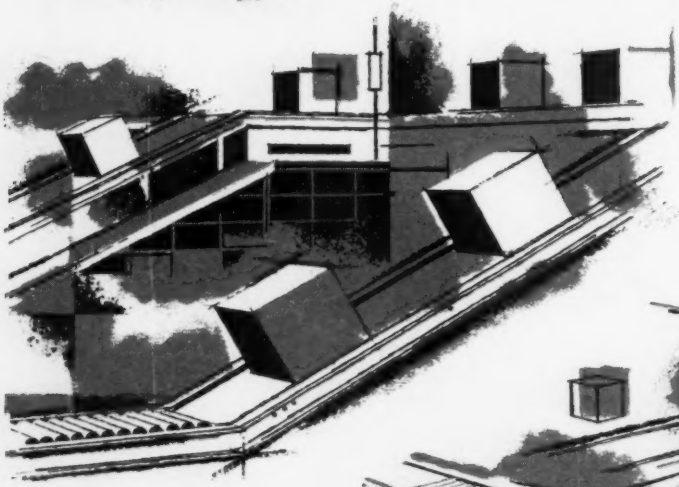

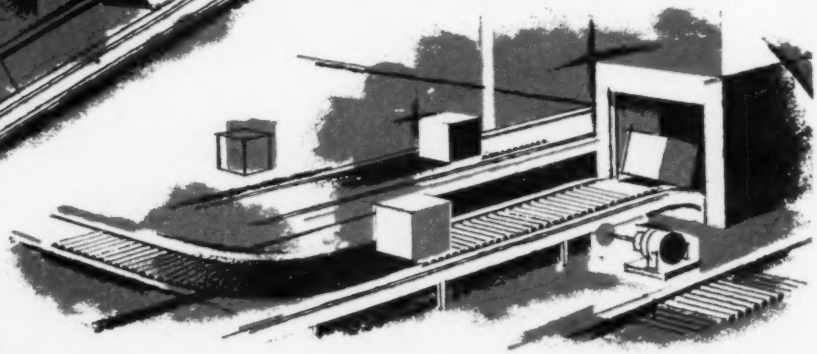

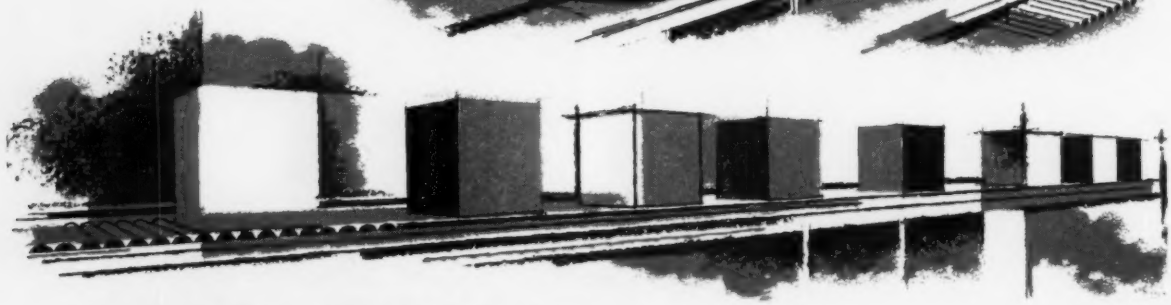

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Tools of Production

For many years the concept of long-term capital equipment in manufacturing has remained unchanged. Based on early manufacturing history, productive equipment has been considered a fixed capital asset much like the building in which it is housed. Much of the concern and study of the subject has been confined mainly to technical details on how to depreciate such machinery to allow for replacement.

Seldom is the problem attacked at the roots. Is all productive equipment a capital asset of long-term use and value? There is much today to contest this view, especially where automated facilities are concerned. The long-term capital asset view may in many ways create a strong deterrent to business vitality and progress. Productivity rise is geared directly to equipment improvement.

Considering that business is carried on primarily to serve the populace, to fulfill its needs and demands, it is imperative that industry keep up-to-the-minute in productive equipment to insure minimum production costs. Retaining equipment outmoded by new developments and improved techniques merely maintains a continuing standard in operating performance which, in the face of rising labor and material costs, results in increasing costs for the consumer.

Manufacturing management must guard against business stagnation in such respects and, today, tax policy on equipment depreciation is one of the major barriers to fast equipment replacement. There should be no unnecessary penalties for investment in upgraded productive equipment to meet competitive conditions. Fast writeoff wherever cost advantage can be shown should be the rule.

Production equipment and lines are, in reality, merely tools—a means to an end. To insure American superiority in producing an ever higher standard of living, manufacturing operations must be upgraded at a faster pace in the future. The need is growing for considering manufacturing equipment and lines as expendable tooling, to be replaced as soon as more modern automated facilities offer distinct operating cost advantage.

Let's remove the shackles and guarantee continued progress and business development.

EDITOR

Evaluating Equipment Costs

Economic feasibility is a primary ingredient of successful automation. Management must evaluate how much automatic operation should be included in the production system. Estimates of equipment costs, comparisons of cost and time factors, and calculations of payoff are essential to this evaluation. These are discussed in the following three articles based on papers which were presented at the Second Conference on Manufacturing Automation at Purdue University.

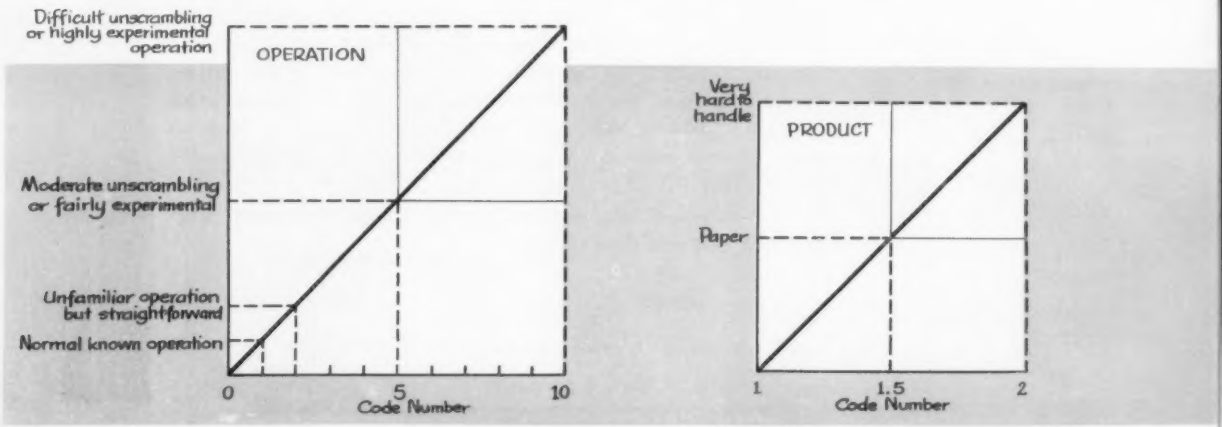
ESTIMATING SPECIAL EQUIPMENT COSTS

By **ROBERT G. DEXTER,** Treasurer, Barkley & Dexter Inc., Fitchburg, Mass.

DEVELOPMENT, design and construction of an automatic machine, particularly a new prototype, raise many interesting problems. Of these problems, one of the nastiest has always been, and still is, to estimate the cost of the project.

Preparing such an estimate, before the design is well advanced, is frequently more difficult than the development of the machine itself. Today, more than ever before, management needs to know, in advance, the probable extent of development commitments. This means that the engineer must attempt to estimate costs before the mechanisms to be used are completely defined. Various systems of more or less educated guessing have been employed in such attempts with results ranging from fairly good to catastrophic.

The following is an estimating system based on the operations to be performed by the machine. Its use requires extensive experience in the auto-



matic handling of materials to permit judging the relative difficulty of various operations and the relative behavior of different materials and products. Properly used, this system has the advantage of breaking estimating down, operation by operation, in such a way that errors in judgment tend to offset each other.

This is by no means a panacea for estimating ills, but represents a systematic and rapid method of applying past experience to a new development.

▶ Steps

These instructions refer to the accompanying estimate form and graphs.

1. List in the left-hand column every operation to be performed by the machine on every product handled in the machine; i.e. (feed paper from roll, edge guide paper, control tension, shear, register, etc.) Wherever a product is indexed or transferred, list it as an Operation each time it is moved even though it is being transferred a number of times in the same nest around a turret.

2. Under Codes in the *Operations* column and opposite each operation listed, place a number taken from the Operation Graph. Interpolate the graph as experience dictates in choosing the appropriate Code Number.

3. In the *Product* column, put after each operation a Code Number taken from the Product Graph based on the difficulty of handling the product in question; for example, identical accurate steel blocks would be 1. Frankfurters would be 2.

4. In the *Speed* column, put after each operation a Code Number taken from the Speed Graph. This speed code number is based on the total number of pieces per minute to be handled by the machine regardless of whether they are handled at high speed in single file or at low speed in a gang.

5. In the *Adjustment* column, put after each operation a Code Number taken from the Adjustment Graph. This adjustment code number is based on the degree of adjustability of each operation.

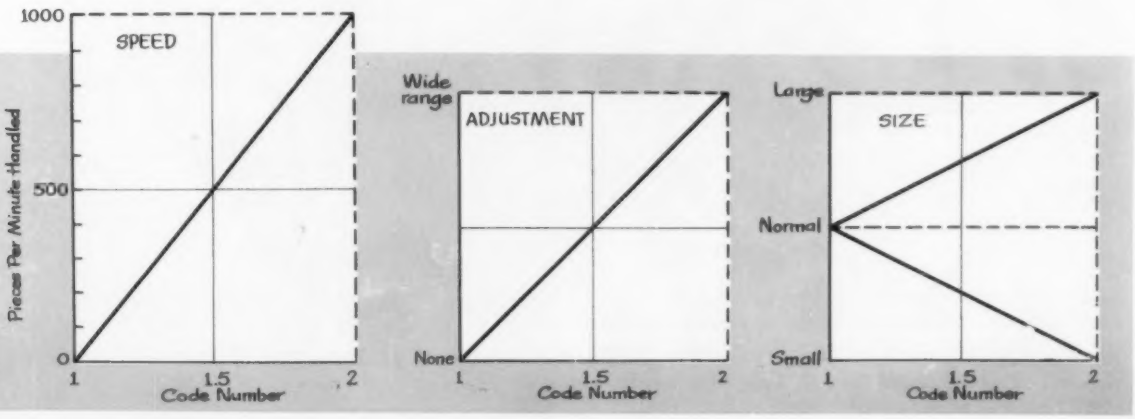
6. In the *Size* column, put after each operation a Code Number taken from the Size Graph. These Code numbers are based on the size of the machine rather than the size of individual sub-assemblies and will be common for all operations; i.e., a very large machine would have the Code 2 placed opposite every operation if you normally build medium size machines. In other words, increase the factor as you depart upward or downward from your normal size range.

7. Now multiply together all the Code Numbers

MACHINE COST ESTIMATE

Operations	Code Numbers					
	Op	Prod.	Speed	Adj.	Size	Accum.
Total Accum. Multiplier Constant					X	
Estimate						

Form used to prepare cost estimate of special production machinery.



in line opposite each operation and put the resultant number in the *Accumulated* column. Do this for each operation.

8. Add up the numbers in the *Accumulated* column to get the total which is an Overall Code Number.

9. Insert the Multiplier Constant which will vary for each company designing and building machinery but should remain fairly constant for your company, changing slowly with changes in overhead and efficiency.

10. Multiply the Overall Code Number by the Multiplier Constant. The product is the estimated Overall Cost of the Machine. This cost includes: design, construction, assembly and a reasonable allowance for perfecting.

▸ Constant Determination

To determine the dollar value of the Multiplier Constant for your company, proceed as follows:

A. Analyze a number of past projects by the above method and determine the Overall Code Number for each. Try not to be influenced in this analysis by knowledge of actual costs.

B. For each job so analyzed, divide the total cost of the job (designed, built and debugged) by its Overall Code Number to get the Multiplier Constant.

C. Take an amount near the top of the range of variation for your Multiplier Constant for use on new estimates.

Note: Should analysis of past projects give a wide variation of "multiplier constant," further analysis should be made to discover other variables which may be causing this. For instance, we have recently found that on each operation where hydraulic systems are used the Code Number from the Operation Graph requires multiplication by 2.

For a company not including profit or overhead in their design and construction costs, the constant may be as low as $200.00. For an efficiently run design and construction group where all overhead costs are charged, the constant should range from $300.00 to $700.00.

In companies building machines produced in quantity, design of the original prototype of a new machine will frequently include extensive study and design for quantity production. In such cases the constant could well equal $1,000.00.

▸ Estimating Additional Machines

After constructing the prototype, a second machine will ordinarily cost approximately one-half as much as the first barring any extensive re-engineering.

In production lots (100 or more), machines will ordinarily cost from one-fifth to one-quarter as much as the first prototype.

▸ Use Of Estimating Procedure

It is suggested that after a reasonable Multiplier Constant is determined from past projects, the estimating system be tried on new projects, reserving such estimates, however for future reference.

After a number of projects have been estimated in this manner, the reliability of the procedure for the particular conditions existing in your plant can be evaluated. At this point, if results are reasonably consistent, the system may be employed in actual estimating.

Automatic punch press accomplishes dieing out, gathering and stacking of paperboard patterns. Cost estimating for such equipment requires extensive experience in the automatic handling of materials.

THERBLIG SYMBOLS

Name	Symbol	Meaning
Search		Eye looking
Find		Eye finding
Select		Pointing
Inspect		Lens
Grasp		Hand closing
Transport empty		Hand empty
Transport loaded		Hand carrying
Release load		Hand releasing
Position		Hand guiding
Preposition		Bowling pin
Use		"Useful"
(Assemble		Put together
(Disassemble		and take apart
Rest		Man sitting
Avoidable delay		Man sleeping
Unavoidable delay		Man falling
Plan		Man thinking
Hold		Magnet and bar

ADMINISTRATIVE ENGINEERING DEPT. – NEW YORK UNIVERSITY

Fig. 1—Therblig symbols used in the analysis of human motions.

COMPARISON OF MAN-TO-MACHINE FUNCTIONS

Partial Table of Machine JAGS Compared to Man Therbligs

Man Therblig	Machine JAG	Examples	Application
1 Grasp	Grippers	Suction cups, Magnets, Solenoids	Paper feed system Magnetic clamps
2 Inspect	Gages	Transducer Photocell	Thickness of parts Transparency limits
		Beta or alpha radioisotopes	Density/weight of tobacco
3 Transport	Conveyors	Chains, Belts Slide	Move chassis Bottling operations
		Vibrators	Hoppers
4 Preposition	Indexes	Sizing gates	Return reversed cigar holders
5 Select		Alignment hoppers	Vibratory feeder Self-align parts by floating on liquid
		Gravity guide	
6 Hold	Jigs and Fixtures	Pneumatics Toggles	Hold engine blocks Drill clamps
7 Release	Ejectors	Loaded springs Compressed air	Self-release dies Routing
8 Assemble Disassemble	Energy Converters	Powered wrenches, screwdrivers Presses	Joining parts Cold welding
9 Plan	Computers	Punched card system Programmer	Automatic miller Automatic lathe
10 Search	Scanners	Interference sensor Optical system	Feelers TV camera

Fig. 2—JAG units, representing basic motions or components of automatic machinery, are compared with Therbligs.

COMPARING MACHINE COST AND TIME FACTORS

What are the realistic cost and time factors involved in developing and building new machines? Here typical data for a standardized machine are compared with those for one of completely special nature with no multiple sales to spread design and build costs. Can develop and build time be accurately forecast? Are debugging time and cost important?

By JOSEPH G. ADILETTA,
Assistant Manager, Electronics Laboratory, American Machine & Foundry Co., Greenwich, Conn.

THIS PAPER is directed toward the evaluation of factors to be considered in deciding on the advisability or economics of constructing a special purpose machine for production, including a method for analyzing automation requirements. The differences in estimating and forecasting costs of a one-of-a-kind machine as compared to a machine to be produced in quantity is presented, with time and cost ratios of engineering vs. manufacturing, design, and debugging.

Determining the Need

It may appear academic, but this fact is so often overlooked it is worthwhile covering once more. Before deciding on what you wish to automate, a complete industrial engineering study of the operations should be made. This study should

MACHINE COST AND TIME FACTORS

encompass process charts, man and material flow charts, methods-motion study, and time study. Unless the operations under consideration are reduced to the most efficient method, the cost of automation may be unnecessarily increased. The information is also necessary in order to make an economic evaluation of the proposed machines.

When we think of automation, we think of replacing a manual operation with a mechanical operation. We are not thinking in terms of a better lathe or milling machine, but rather of substituting machines for the work previously performed by the operator. Sometimes we are satisfied to substitute a mechanical means of transfer of parts between work stations to do away with the requirement for manual transport of material between these work stations. When more complex automation is considered, it is viewed, understandably, with more fear and risk. It seems reasonable, therefore, that the best way to *reduce the cost* of automation is to *reduce the required complexity of the machine.* Since the complexity of a given mechanism will vary directly with the complexity of the manual operation which it is replacing, it follows that a reduction in the complexity of the manual operation will result in a requirement for a less complex and less costly machine.

Most people in production activities will be familiar with the contributions made by the Gilbreths, Frederick Taylor, and others in the field of motion study and manual operation analysis. They have defined the basic motions of any operation in terms of "therbligs" and have determined that an operation can be reduced in cost by reducing the complexity or frequencies of these motions. These therbligs, *Fig.* 1, are shorthand symbols representing human actions. It has been shown that all of man's factory operations may be expressed by one or more therbligs. They include such motions as searching, selecting, inspecting, grasping, transporting, positioning, holding, and waiting.

In applying automatic machinery to production processes, the machine is substituted for the basic actions represented by the Therbligs.

In order to illustrate this concept more clearly, I would like to propose a unit of machine analysis called a JAG, *Fig.* 2. A JAG is the machine equivalent of a therblig in that it represents a basic motion or component of automatic machinery. It should be possible to analyze a complex machine in terms of its JAGS. For instance, a conveyor belt would be a "transport" JAG which would replace a similar manual motion represented by the "transport" therblig. Machine grippers would be the "hold" JAG, etc.

Some companies are specializing in particular areas of machine components, for example indexing machines. Basically, these indexing mechanisms can be considered the "prepostion" and "hold" JAGS. Likewise, the pneumatic or hydraulic clamping accessories represent other "automation" JAGS.

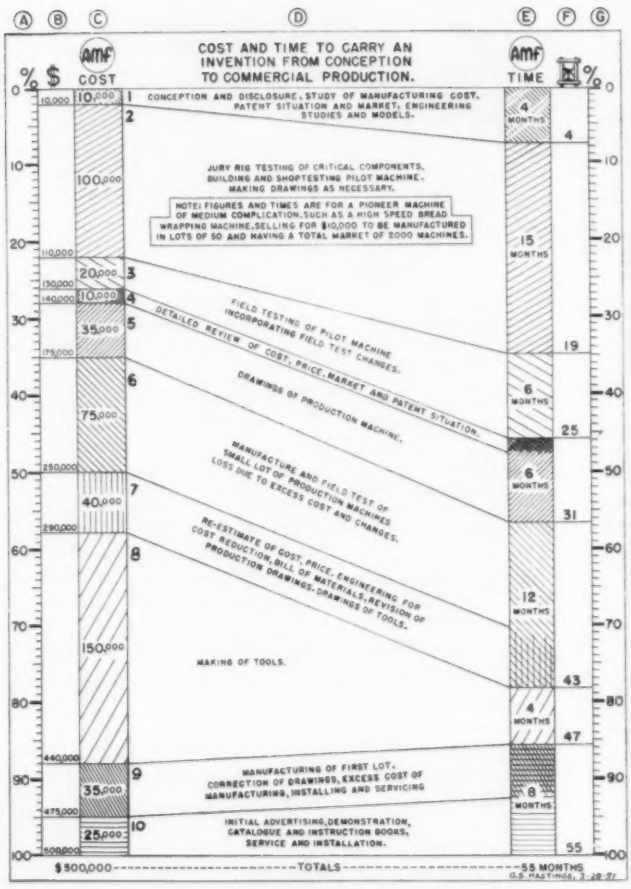

COST AND TIME TO CARRY AN INVENTION FROM CONCEPTION TO COMMERCIAL PRODUCTION.
COST
TIME
CONCEPTION AND DISCLOSURE, STUDY OF MANUFACTURING COST, PATENT SITUATION AND MARKET, ENGINEERING STUDIES AND MODELS.
JURY RIG TESTING OF CRITICAL COMPONENTS, BUILDING AND SHOPTESTING PILOT MACHINE, MAKING DRAWINGS AS NECESSARY.
NOTE: FIGURES AND TIMES ARE FOR A PIONEER MACHINE OF MEDIUM COMPLICATION, SUCH AS A HIGH SPEED BREAD WRAPPING MACHINE, SELLING FOR $10,000 TO BE MANUFACTURED IN LOTS OF 50 AND HAVING A TOTAL MARKET OF 2000 MACHINES.
FIELD TESTING OF PILOT MACHINE INCORPORATING FIELD TEST CHANGES.
DETAILED REVIEW OF COST, PRICE, MARKET AND PATENT SITUATION.
DRAWINGS OF PRODUCTION MACHINE.
MANUFACTURE AND FIELD TEST OF SMALL LOT OF PRODUCTION MACHINES LOSS DUE TO EXCESS COST AND CHANGES.
RE-ESTIMATE OF COST, PRICE, ENGINEERING, FOR COST REDUCTION, BILL OF MATERIALS, REVISION OF PRODUCTION DRAWINGS, DRAWINGS OF TOOLS.
MAKING OF TOOLS.
MANUFACTURING OF FIRST LOT, CORRECTION OF DRAWINGS, EXCESS COST OF MANUFACTURING, INSTALLING AND SERVICING
INITIAL ADVERTISING, DEMONSTRATION, CATALOGUE AND INSTRUCTION BOOKS, SERVICE AND INSTALLATION.
$500,000 TOTALS 55 MONTHS

Fig. 3—Plot of financial and chronological history of the development of a line of automatic bread-wrapping machines to be manufactured in quantity.

As in motion study, where a reduction in cost is achieved by a reduction in the time (or difficulty) of performing an operation, in establishing the performance requirements of automatic machinery, the use of less complex JAGS should be sought.

If we analyze our machine operations, therefore, in the light of the complexity of a manual operation, and methodize accordingly, we will arrive at the most economical basis for substituting a machine to perform the equivalent manual function.

Having determined the need and economic limits justified for developing your own special machinery by application of Industrial Engineering practices including the simplification of the production method, we may proceed to review and compare some cost and time factors experienced in development of automatic machines. The examples will cover the analysis of a pilot production model as well as a one-of-a-kind special

machine which will be of most interest to those of you considering automating.

Cost and Time Factors

Some years ago G. S. Hastings, vice president of A.M.F., prepared a chart on which he plotted the financial and chronological history of the development of a line of automatic bread-wrapping machines, *Fig.* 3. Let us review these factors in more detail.

The first item covers the initial problem of design concept and patent protection. It also includes estimates of manufacturing costs and size of market. You will note that this phase cost $10,000 and went through a four months time period. The second phase of this development included jury rig testing of the more questionable mechanisms. A rough pilot machine for proving feasibility was made in the model shop with a very minimum of drawings. This element cost $100,000 and time period was fifteen months.

The third phase involved field testing of the pilot machine, with field changes being made as necessary. The cost of this phase was $20,000 over a six months period. At this point, the fourth phase, involving detailed review of manufacturing costs, possible sales price, potential market, and patent situation, cost $10,000 and was accomplished simultaneously with the drafting phase, taking about one month. Design and drafting took six months and $35,000.

The sixth phase was devoted to a trial run of manufacturing a small lot of machines for field testing and the checking out of tooling. The cost for this phase was $75,000. The twelve months time used overlapped phase seven, which cost $40,000 and covered the re-estimating, methodizing, engineering for cost reduction, preparations and planning for production, and designing of production tools.

Phase eight covered four months at $150,000 for the purpose of fabricating production tooling. Phases nine and ten cost respectively $35,000 and $25,000 over an eight months period with some overlap. These phases involved manufacturing cost of the first lot, correction of drawings as the result of production, and installing and servicing. Phase ten accomplishments included the initial advertising, demonstration, catalog and instruction book, and servicing and installation.

The total cost for this machine of medium complexity was $500,000, over a fifty-five months period. Such a bread-wrapping machine, *Fig.* 4, is manufactured in lots of fifty for a market of 2000 and sells for approximately $10,000.

To compare this type of machine development with building the one-of-a-kind machine, I prepared an equivalent chart for the standardized machine. No particular machine is used as the basis for the chart, *Fig.* 5, but an attempt was made to plot the costs for the various elements of a most representative machine of medium complexity. In a sense, this type of machinery is supersophisticated tooling, since it usually combines the elements of tooling as well as machining and assembly.

As in the first example, the concept, the problem, and the required performance must be established. For this phase, the cost is $3750 and the elapsed time is half a month. In phase 2, a tentative design is created and an associated review of the economics is accomplished; approximately the same time and cost are involved.

The next step may be to make special jury rigs for the critical mechanisms, to accumulate experimental data, and to select important materials. This period averages 2.4 months at a cost of $11,250.

Step 4, covering design layouts, subassemblies, components, and commercials takes approximately 2.4 months and costs $11,250. Step 5 includes the detailing and drafting, materials, purchasing, continuation of analysis of economic factors, and planning schedules for establishment of the date at which this machine can be installed in the production line. Three and one-half months and $15,000 are needed to complete this phase.

The next step, known as the "hardware stage," includes the debugging, engineering tests, redesign, modifications, calibrations, and final adjustment and averages approximately 13 months at a cost of $22,500.

The last step is the installation in the production line and completion of as-built drawings, maintenance plans, and operating instruction. At this point, a certain amount of trouble shooting is to be expected with the associated equipment. The cost for this work is $7500, the time a little

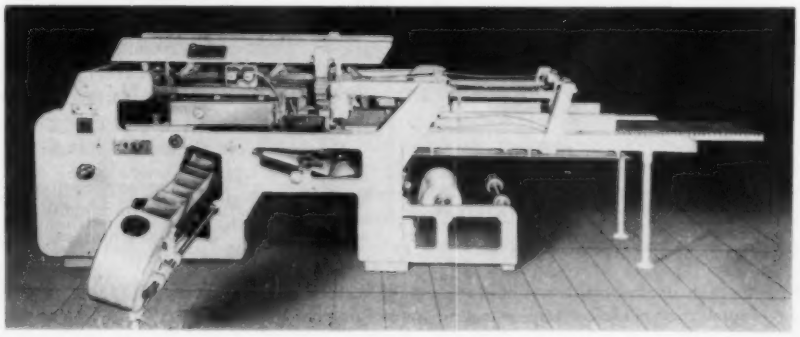


Fig. 4—Cost and time factors for developing an automatic bread wrapping machine such as this are given in *Fig.* 3.

more than a month.

The total cost for this average machine is $75,000, and the production time required is two years.

In comparing the cost of a one-of-a-kind machine for automation as compared to a production machine, we must remember that the bread-wrapper referred to above has a selling price of approximately $10,000 because development costs have been amortized over 2000 units. To make a more specific comparison, the cost and time of the same bread-wrapper is plotted, *Fig.* 6, on the basis of developing a single machine. In this example, the cost of tooling, advertising, marketing, patent rights, and production engineering have been eliminated. The development cost in this case is $165,000 instead of $500,000, *Fig.* 3, and the time required 30 months instead of 55 months.

Notice the similarity in the items that are involved in the development of special machinery, whether it be one-of-a-kind or a production model. In comparing the bread-wrapper with the hypothetical machine to be developed for automation, we should remember that the bread-wrapper is composed of a number of automatic operations including transfer, orienting, sealing, and wrapping. An interesting factor to consider is the percentages or ratios of the various steps to the total price and time. The percentage scales are included in the charts for this purpose.

So much for historical and theoretical data on development costs and time factors. The discussion of variations in the ratios could continue as other types of machines are considered but that is beyond the scope of this paper, and therefore we shall move on to the subject of *forecasting* engineering costs and debugging time. This is an area of great importance but the newcomer to estimating and forecasting engineering is cautioned to move gingerly and to analyze his company's history and experience carefully.

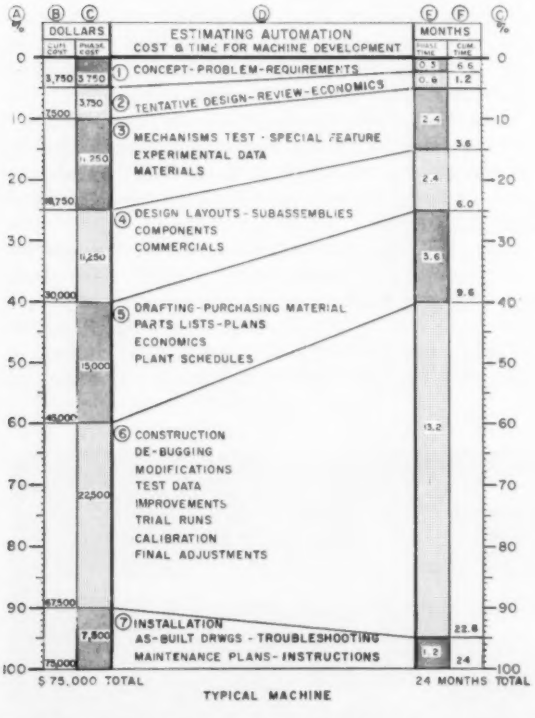


Fig. 5—Plot of financial and chronological history of development of a typical one-of-a-kind special machine.

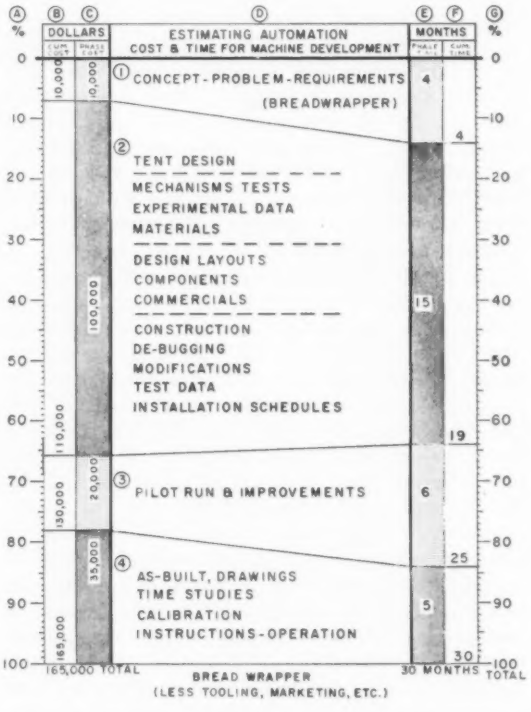


Fig. 6—Plot of *Fig.* 3 for an automatic bread-wrapping machine as it would have been if this were a one-of-a-kind machine development.

Forecasting Costs and Debugging Time

In considering the advisability of building your own machinery with your own engineering and shop facilities as compared with buying ready made or specially designed equipment, the following factors should be evaluated:

1. The experience of your engineering department in automatic machinery.

2. The emphasis on electronic or mechanical features.

3. Your personnel's knowledge of the present state of the art.

RATIOS OF FACTORS TO COST

Phases	Factors	%	Functions
Step 1	Concept requirements	5	Engineering
Step 2	Tentative design review, approvals	5	Engineering
Step 3	Jury rigs	15	Engineering - Shop (5%) (10%)
Step 4	Design layouts Subassemblies	15	Design - Engineering (10%) (5%)
Step 5	Drafting	20	Drafting
Step 6	Model test - Debugging	30	Shop - Engineering (25%) (5%)
Step 7	Revised drawings Instructions	10	Design - Engineering

Fig. 7—Average cost ratios for the development of one-of-akind special machines. Step numbers under *Phases* refer to steps identified in *Fig.* 5.

4. The skills and flexibility of your manufacturing operation.

5. The long range plans of your company on this subject (if much of this development is anticipated it may pay to staff your engineering department accordingly).

6. The historical cost data of your company.

The results of these considerations should determine the advisability of subcontracting your requirements to other experienced machine design organizations, or taking advantage of your familiarity with the product by developing your own equipment.

Some general ratios of engineering to total cost follow. It is realized that these ratios may change considerably if: 1. The operation requires extremely close tolerances. 2. The operation is unusually hazardous. 3. The materials used must be very highly stressed.

As shown in the preceding charts, there is generally a close cost ratio of approximately 50 per cent engineering to 50 per cent manufacturing. Several average cost ratios are presented, *Fig.* 7.

Another ratio that may be used is that of cost of materials to total price. This is a difficult ratio to use on experimental machinery but may be applied at a later stage of development when the final design is complete enough to have made manufactured items. For instance, in general structure work, the material to labor cost would be approximately 1 to 2 whereas in the development of a small mechanism requiring many machined parts, a ratio of 1 to 10 (material to labor) would probably be more accurate.

Other ratios or rules of thumb for projecting total costs might be based on the number of electronic tubes (such as $20 for a two tube chassis), the number of wiring terminations in a large rack (such as 3.0 to 5.0 minutes per terminal for wiring), etc.

In estimating or forecasting engineering costs, we must bear in mind the difference between "Productive Time" and "Elapsed Time." In manufacturing operations, only actual machine or productive time is costed; "in-stores" or elapsed time is not charged to the customer, other than by an overhead or burden method. However, in engineering we usually have to consider a large percentage of elapsed time caused by problems of coordination and relationships of people, which are directly chargeable to the job. We should therefore estimate costs for engineering-design personnel in terms of days or weeks rather than hours, although the data and costs may later be handled on a manhour basis.

There are contingencies normal to an engineering activity which should be anticipated and predicted on the basis of knowledge of the project, state of the art, organizational structure, and management policy. They represent real time and material which should be determined by the engineer as part of the basic cost and time estimate.

Contingencies external to the project control may be classed as indeterminants and allowed by management as a per cent of the overall estimate. These conditions may represent as much as 20 to 40 per cent of project costs.

How much time and cost should be allowed for debugging? The answer depends on your engineers' experience and the complexity of the machine. As a starting point, assume debugging time equal to fabrication time of model; the cost would be related more to the engineering manpower than the fabrication cost!

All this leads to a rather controversial point in forecasting engineering design, debugging, and modification costs. When these costs are underestimated, and this happens quite often, the explanation is sometimes that "unexpected developments" created the overrun. In a good many cases, the overrun is the result of misforecasting due to estimating by hourly yardsticks which are not applicable, or too optimistic attitudes about possible problems and procedural delays. Make a checklist for possible pattern of your most frequent troubles and then anticipate them! Your cost and time forecasts will then become more accurate as experience (with data analysis) is accumulated.

In conclusion let us quickly retrace this facet of automation: Before one writes the specifications for the machinery, a complete analysis of the operation is made including time-motion study; after this is done the planning, estimating, and economic evaluation is made bearing in mind the time-and-cost factors for engineering machine development; finally, forecasting of costs and time for development is possible, thereby permitting you to throw the switch to start your newly automated line on schedule.

HOW TO FIGURE PAYOFF

Direct labor costs no longer provide a valid payoff basis. What factors enter into the calculation of payoff for automation today? Analysis must include materials savings, machine utilization, reduced waste, increased output, product design, etc.

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IN THIS INTRICATE and interesting field of automation it is not enough that the automation project be desirable to the engineer and the production man, it must also be desirable to the man who must approve the expenditures. This means the various advantages and disadvantages of the automation equipment over the present equipment must be translated into money. As the net advantage of the proposed equipment, commonly called payoff, will significantly affect the decision to buy the new automation equipment, its preparation should be as thorough as the engineering study it represents. Hence our current topic "How To Figure Payoff."

The payoff calculation or more specifically the payoff calculation form does more than provide a thorough, systematic way of making the payoff calculation. It is the evidence to top management that a thorough, competent analysis has been made by the engineering department. As such, it may do more to sell the proposed new equipment than the actual payoff figure itself.

The demonstrated competence of the engineering department is the key to the acceptance of the proposal by top management.

The payoff calculation is one step in a series of steps that start with the consideration of many alternatives to replace the present equipment. A rough or preliminary analysis eliminates all but one alternative which then becomes the subject of a detailed analysis. A payoff calculation follows to determine if the replacement is financially sound. The final step to the cycle is the post installation review. Once the installation is running smoothly, a review should be made of all costs to date and of the current rate of savings for comparison with the predictions on the payoff calculation form.

Only the last two steps, the payoff calculation and the post installation review will be discussed in this paper.

▸ Shortage of Money

There are several basic concepts which are fundamental to payoff calculations and which should be understood before the calculation itself is undertaken. The first of these is the shortage of money. As in our personal lives, a corporation always has more uses for money than it has money available.

When the demand for money in a corporation exceeds the funds available, the corporation may borrow money or sell stock. Borrowed money has the risk that if there is a business recession, the corporation will be unable to pay the interest without giving up its profit, or worse, may even go into bankruptcy. If more stock is issued, besides the obvious drawback of dividing the profit into more pieces, there is the serious prospect that the additional stock may upset the existing balance of ownership, and, in turn, threaten the tenure of the management. Where possible, a corporation stays within the funds available.

To take advantage of the best projects and yet to stay within the funds available, many corporations make use of what is called a capital budget. In the preparation of the capital budget, all the requests for facilities funds are assembled and evaluated as to financial return, risk, and need. The more desirable are listed as scheduled or budgeted for the coming year. This is the obstacle course the payoff calculation form must pass before the project can become a reality.

▸ Interest

The second basic concept is that the use of money requires the payment of interest. The payment of interest, at times, has the ring of the old miser in it, and yet it is a basic fact of business. If we borrow money, we must pay interest.

(1) Subject of Analysis _____ (2) Study Number _____

_____ (3) Date _____

_____

(4) Rate of Production _____

Proposed Equipment		Present Equipment	
(5) Description		(13) Description	
(6) Cost of Equipment	$	(14) Machine Number	
(7) Cost of Installing		(15) Date Installed	
(8) Engineering Cost		(16) Installed Cost	$
(9) Break-In Cost		(17) Present Salvage Value	$
(10) Total Investment	$	(18) Planned Major Repairs	
(11) Estimated Primary Life		(19) Present Investment	$
(12) Estimated Salvage Value	$	(20) Estimated Life	
		(21) Estimated Salvage Value	

	Proposed	Present
(22) Capital Costs		
(23) Depreciation	$	$
(24) Interest at ____%		
_____		
_____		
(25) Direct Costs		
(26) Direct Labor		
(27) Indirect Labor		
(28) Set-Up Time		
(29) Material Savings		
(30) Spoiled Work		
(31) Tool Costs		
(32) Maintenance		
(33) Power Consumption		
(34) Floor Space, if usable		
(35) Property Taxes and Insurance		
_____		
_____		
(36) ANNUAL COST	$	$
(37) Marginal Costs		
(38) Superior Product (sales advantage)	$	$
(39) Additional Capacity (improved delivery)		
(40) Floor Space (if not readily usable)		
(41) Assembly Cost (due to closer tolerances)		
(42) Product Design (better matching parts)		
_____		
_____		
(43) TOTAL MARGINAL COSTS	$	$

Fig. 1—Detailed payoff calculation form.

If we have extra money, we can deposit it in a bank or buy bonds and obtain interest.

Whether you borrow money or whether you loan money, the greater the risk, the less the security, the greater the interest.

When money is used to buy equipment for a project, interest is a very real expense. If the money is borrowed, interest must be paid. If the money is from within the corporation, it could be loaned and interest received. Either way, money is spent or lost.

The minimum rate of interest charged to the project would be the bank rate plus an amount equal to the risk involved considering the project may not work out. Actually, the rate of interest used will depend upon what other projects through-

out the corporation can earn and will probably be at least several times the savings bank rate of interest.

Depreciation

The third concept is that of depreciation. Depreciation is a prepaid operating expense that must be allocated by some means to the cost of doing business each year of the life of the machine. There are three common methods of depreciation: 1. Straight line. 2. Declining balance at double the straight line rate. 3. The sum of the years digits.

As a piece of equipment ages, its usefulness decreases. The declining balance at double the straight line rate and the sum of the years digits are accounting methods of charging high depreciation charges during the early years when the equipment's usefulness is highest. The accountant is concerned more with the physical life of the equipment than is the engineer.

The engineer desires the proposed machine to secure dependable service, low cost, or close tolerance. When the proposed machine has aged to the point that a second machine is required to obtain the desired dependability, low cost, or close tolerance, the primary life of the proposed machine has ended. This life may very likely be much shorter than the life upon which the accountant will base his depreciation rate. As the service performed during the shorter or primary life will be substantially constant, the straight line depreciation method will give better cost figures to the payoff calculation. The best estimate of the primary life should not be shortened to compensate for the risk as the interest rate has already taken into account the risk involved.

Book Value of Equipment

The use of depreciation gives rise to a new term, book value of equipment. The book value is the difference between the original installed cost of the equipment and the accumulated amount of depreciation charged to operating expenses since installation. It is money that has already been spent but has not yet been allocated to operating expenses.

This analysis is to determine if the present equipment as it is today should be sold and replaced by the proposed equipment. Therefore, the engineer will use the value of the present equipment today or the realizable salvage value in calculating the payoff; it should be noted that this is not necessarily the book value.

Income Tax

In all the previous discussions and in the payoff calculation forms the effect of income tax is ignored. This is done because the income tax implications frequently follow the gains or losses of the business in general, and therefore would not ordinarily affect the relative merits of the study.

Detailed Payoff Calculation Form

The basic concepts have all been discussed. The way is clear to discuss the payoff calculation itself, *Fig.* 1. The forms used in payoff calculations are composed of two sheets: One, the cover or summary sheet; and two, the detailed calculation sheet which will be discussed first. All entries on the form are numbered:

1. *Subject of the Analysis*—A brief description of the operation being studied in general terms.

2. *Study Number*—If many analyses are being prepared, the study number will aid identification.

3. *Date*—The preparation date.

4. *Rate of Production*—The rate of production is important as it is the basis for the comparison. If the equipment is for a special purpose, list the production as well as hours run. If for general purposes, list the shifts also.

5. *Description*—The description should be specific with equipment name, supplier's name, model number, and capacity.

6. *Cost of Equipment*—The freight is included with the selling price. Where special tooling or material handling equipment are required initially, it should be included. On automation projects, the special equipment can easily be 10 to 15% of the total cost.

7. *Cost of Installing*—This covers the cost of the actual installation of the equipment whether by the mechanical department or by outside contractors.

8. *Engineering*—This is for special engineering costs. For example, if it is a major project and has had several engineers assigned to it, their cost would be listed here. On automation equipment, especially for the first project, this cost can be 5 to 10% of the total.

9. *Break-In Cost*—Very seldom does equipment work immediately as planned. There are frequently adjustments needed, and especially on automation projects, some redesign work to be done. This cost may be as much as 10% of the entire project.

10. *Total Investment*—This is the sum of (6) through (9) and represents the immediate cash necessary to place the equipment in operation less the realizable salvage value of the present equipment.

11. *Estimated Primary Life*—Obsolescence in automation equipment is high. Besides the advances in automatic equipment, the project may be redesigned or the volume of production may radically change. In this estimate, we are emphasizing the primary life. Once the tolerances or capacity has declined to where the equipment must handle other work of less precision or lower volume, the primary life has ended. Do not, however, reduce the best estimate of the life to take account of the risk because the rate of interest on the capital used adequately covers the risk. The life you select will probably be shorter than the life used by the accounting department. This is an economy study that requires due conservatism and necessitates elimination of possible secondary usage values from consideration.

12. *Estimated Salvage Value*—This is the value the equipment will have at the end of its primary life.

Subject of Analysis _____ Study Number _____

_____ Date _____

Results:

Include in results:

(1) Annual savings or payoff.

(2) Investment (cost of proposed equipment less investment of present equipment)

(3) Estimated time to recover investment.

(4) Marginal costs.

(5) Opportunities for training personnel in specialized skills.

(6) Other advantages.

Discussion:

Include in discussion:

(1) Alternatives considered and rejected.

(2) Risks involved in estimates.

(3) Disposition of employees made unnecessary by this installation.

(4) Source of level of production used.

(5) Source of cost data for direct labor.

(6) Source of cost data for indirect labor -- specify groups, e.g., material handling.

Recommendations:

Approved by: _____

_____

_____

Fig. 2—Summary payoff calculation form.

It does not mean the equipment will be sold then, but for this economy study, we need the value as if it were to be sold. The actual salvage value will be reduced by the removal costs.

13. *Description*—This should be specific with equipment name, supplier's name, model number, and capacity.

14. *Machine Number*—The corporation's identification number.

15. *Date Installed*—The date the equipment was installed, not the date it was purchased. In some projects, there may be a year or so difference between these dates.

16. *Installed Cost*—This is available from the accounting department if not from the equipment records.

17. *Present Salvage Value*—This is the money the equipment would receive on the open market less the removal costs.

18. *Planned Major Repairs*—Very frequently the question of replacement arises because of a contemplated major repair. To properly compare the proposed to the present, the cost of the planned major repair is an investment above the salvage value and must be added to it.

19. *Present Investment*—Total of (17) and (18). This is the money invested in the present equipment and is for comparison with the total investment of (10).

20. *Estimated Life*—The estimate here should give the lowest cost per year. If planned major repairs are made, the life will probably be several years. If no repairs are contemplated, the lowest cost per year will probably be obtained by using one year as the life.

21. *Estimated Salvage Value*—This is the value of the equipment at the end of the life estimated in (20) less the removal value. In these times of inflation, it may be more than the present realizable salvage value.

22. *Capital Costs*—This divides the costs concerned with the use of money from the direct costs.

23. *Depreciation*—Here depreciation is the reduction to an annual cost of the investments of the two proposals. Any item of costs which is present at the

start of the project is proportioned over the primary life of the equipment. The total investment in (10) or (19) minus the estimated salvage value in (12) or (21) divided by the life in (11) or (20) gives the yearly depreciation. As an example, if the total investment were $12,000.00, the estimated salvage value were $2,000.00, and the primary life were five years, then the depreciation would be $12,000.00, less $2,000.00, divided by five or $2,000.00 per year.

24. *Interest at _____%*—The interest value will be provided by the finance section of your corporation. The approximate formula to determine the average interest is reasonably accurate when the life is less than ten years. For most automation equipment, this is a long life. Therefore, in the interest of simplicity, the approximate interest formula is used:

$$(I - S)\frac{i}{2}\frac{(n+1)}{n} + Si = \textit{Average Yearly Interest}$$

When: I = Investment
S = Salvage Value
i = Rate of Interest
n = Life

25. *Direct Costs*—Those costs that can be directly allocated to the equipment.

26. *Direct Labor*—Two different methods of doing a job are being compared. The production units used for both methods should be the same. The hours and rate for the direct labor can be obtained from the industrial engineering department. In these and all hourly rates that follow, be sure the fringe benefits which are available from the accounting department are included.

27. *Indirect Labor*—Here there can easily be oversights. The indirect help should be considered separately; janitors, material handlers, production clerks, supervisors, inspectors, receivers, and shippers. The advent of automation with its enormous appetite and expensive downtime usually profoundly affects indirect labor. As the cost may go up or down, a study must be made. Once the decisions are made, the hours times the rates will give the cost.

28. *Setup Time*—This may not apply. If the equipment handles several sizes, setup time is involved. We have frequently found that setup time on automation equipment is longer than is anticipated; what appear to be simple, minor adjustments are often not as simple and minor as planned. The cost would be the product of the hours and the rates.

29. *Material Savings*—This does not refer to spoiled work, but to savings in design. A frequent gain from automation is a reduction in the material used to form a finished piece. The material savings would be the reduction in cost of material for the estimated production including the savings in freight, plus the variable overhead. The variable overhead is obtained from the accounting department.

30. *Spoiled Work*—The cost here would be the material cost plus the direct labor on the pieces less the salvage value if the spoiled work has a resale value. To this cost would be added the variable overhead.

31. *Tool Costs*—This is for the recurring tool costs and does not include the initial special tools which were covered in the equipment cost before. The purchase price plus the freight would be the cost to use.

32. *Maintenance*—This expense usually includes indirect labor, parts, and outside services. In considering the maintenance costs in automation equipment, the possibility of one or several mechanics being assigned permanently to the equipment to minimize expensive downtime should be considered. Whether or not assigned mechanics are used is not always the choice of the engineer. Frequently, assigned mechanics are used during the break-in time and then released. The cost would be hours times rate plus the cost of parts and services from outside sources.

33. *Power Consumption*—In power consumption, be careful not to use the average rate. The extra power needed will be on top of the existing load and should be charged at the rate which applies to the extra load. This will probably be the cheapest rate.

34. *Floor Space*—Multiply the floor space required by the annual cost per square foot. The annual cost should be obtained from the accounting department. If the space is not readily usable, do not enter the cost here but in (40).

35. *Property Taxes and Insurance*—The costs for these items can be obtained from the accounting department. If the costs are given as a percentage, be sure of the identity of the factors against which the percentages apply.

36. *Annual Cost*—This is the annual cost for the proposed and the present equipment. The difference between the present cost and the proposed cost is the payoff.

37. *Marginal Costs*—Those costs which are more difficult to evaluate are called marginal costs. If a definite value can't be given but a range could, record the range.

38. *Superior Product*—A frequent advantage of automation is a more salable product. The sales department may be able to place a definite value on it; if not a definite value, probably a range of values.

39. *Additional Capacity*—The ability to make quicker deliveries will frequently allow the sales department to make sales otherwise lost. Again they may be able to place a value or a range of values on this advantage.

40. *Floor Space*—If the floor space is not readily usable now, it probably will be in the future. In the normal course of business, empty space is put to use.

41. *Assembly Cost*—When parts are manufactured automatically, it may be possible to consistently hold closer tolerances than when the same job is done on less automatic machines. This will allow the parts to be assembled with less hand fitting. The production superintendent may be able to place a value on this.

42. *Product Design*—This is another facet of assembly cost. When the products are consistently held to closer tolerances, the design of the matching parts may be changed. Frequently they can be made of a cheaper material or by a cheaper manufacturing process. The design engineer may be able to place a value on this.

43. *Total Marginal Costs*—This is the total of the marginal costs. It has not been added into the annual cost because of its indefinite nature.

▶ Summary Payoff Calculation Form

The reviewing executives of the payoff calculation sheet, *Fig.* 2, more commonly called request for expenditure of capital funds, will not take the

time to review thoroughly the detailed payoff calculation form. Besides desiring a summary of the form, they would like to have some specific questions answered which are based on analyses of past proposals which did not work out as planned.

In summarizing the results, the following items should be included:

1. *Annual savings or payoff*—This is the difference between the annual costs of the present and the proposed equipment. This is the money that will be saved each year by the purchase of the proposed equipment.

2. *Investment*—This is the difference between the total investment of the proposed equipment (10) and the present investment of the present equipment (19). The present investment includes the cost of planned major repairs. This money will be spent if the proposed equipment is not purchased. Therefore, it should be subtracted from the investment that will be required to buy the proposed equipment.

3. *Estimated Time to Recover Investment* — The money returning from the purchase of the proposed equipment is the annual savings plus the capital charges. This divided into the investment of (2) will give the estimated time to recover the investment.

4. *Marginal Costs*—The advantages and/or disadvantages of the marginal costs (37) to (43) are summarized here.

5. *Opportunities for Training Personnel in Specialized Skills*—This is a very important plus. It is not possible to hire all the skilled personnel a corporation needs; the majority must come from within. Be specific here as to what men are trained with what skills.

6. *Other Advantages*—As all the tangible advantages are listed on the detail payoff calculation sheet, these will be intangible advantages. Quality, morale, holding engineers are all examples of strong pluses that, if applicable, should be listed.

Under discussion, besides discussing any result that needs clarifying, the following questions should be answered:

1. *Alternatives Considered and Rejected*—Besides indicating the analysis was thorough, it may answer some reviewers specific question could it be done better by another alternative which was investigated and found not to be the best alternative.

2. *Risks Involved in Estimates*—The reviewers should be aware of any definite risks. If this is the first type machine ever built and there is an outside chance it won't work, let them know. They are accustomed to taking risks, but like to weigh the risks in advance.

3. *Disposition of Employees Made Unnecessary by This Installation*—Many times a project is successful, the job is done cheaper, but the pay roll is the same. For example, the department now has one less machine operator, but one more clean-up man. Also from policy, some corporations do not like to discharge an employee because of improved equipment. Here the displaced employee must be fitted into another position before the project can be approved.

4. *Source of Level of Production Used*—The source may be the sales forecast. The reviewers may be aware of changes in the market not yet reflected in the sales forecast.

5. *Source of Cost Data for Direct Labor*—If the data came from a production supervisor without an industrial engineering background, the answer could be honest and yet unreliable.

6. *Source of Cost Data for Indirect Labor*—Specify groups, e.g., material handling. This area especially in considering an automation project could be a source of erroneous conclusions. As mentioned earlier, an automation project changes the demands upon almost all indirect groups.

Should the answering of these questions take more than a sheet, they should be summarized and the complete answers attached as a third page to the payoff calculation sheets.

Post Installation Review

Once the payoff calculation forms are completed, the project approved, and the installation made, there is still one more step in the cycle. At some interval, say six months or a year after the installation is running smoothly, a post installation review should be made. The review should include costs as well as savings. If it is not a question of fact, wherever possible, the figures should be determined in a way fundamentally different from the method used in the study. If the equipment uses a large amount of electricity, use recording wattmeters to record actual kilowatts consumed. If the direct labor savings were determined on so much time per piece, compare the department pay roll now with what it was before the equipment was installed. If there was to be one material handler less, count to see if the department has one less man, not if one less man is assigned to the equipment. This is very important. Frequently a project will appear very successful on a review by repeating the original calculations whereas a different approach will show the savings have not been realized.

Honesty here is very important. It is surprising how many people know of the success or failure of a program with no direct knowledge. Remember the high interest rate is based on the corporation's experience that all projects are not successful.

This report will also be very helpful in guiding the engineering department in making future payoff calculations.

Conclusion

The important phases of the payoff calculation have now been covered. To review briefly, they are:

1. Make a thorough, competent engineering analysis of the alternative selected as best.

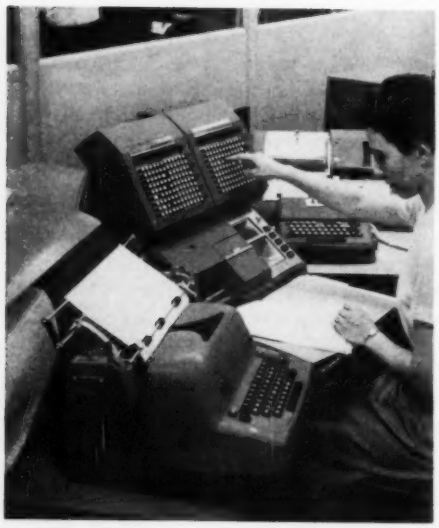
2. Calculate the payoff in such a way that the reviewer is conscious that a thorough, competent analysis was made.

3. Summarize the calculation on a separate form. In the summarization, indicate by the discussion that the engineer was aware of and avoided the common pitfalls in calculations of this kind.

4. Review the installation after it is running successfully to determine if the anticipated costs and savings were realized. In the review, where undisputable facts are not available, compute the savings in a fundamentally different way than was used in the initial calculation.

1

Daily transactions are entered and daily balances are computed by this IBM 650 computer installation at Timken's headquarters in Canton. Machine is the core of integrated data processing system that links selling, manufacturing, warehousing and shipping functions of corporation's bearing operations. Computer output is used to prepare a daily work sheet called "Scheduler's Reference Report" which is used by personnel of Sales Planning Dept. to make decisions relative to incoming orders. On the report are current data of every inventory item, including: *Pieces on Order* for current and next four months, *Pieces in Inventory, Manufacturing Schedules* which may be past due or are for current month or next month. Computer operation time is less than 2 seconds per inventory item. Both input and output are on punched cards.



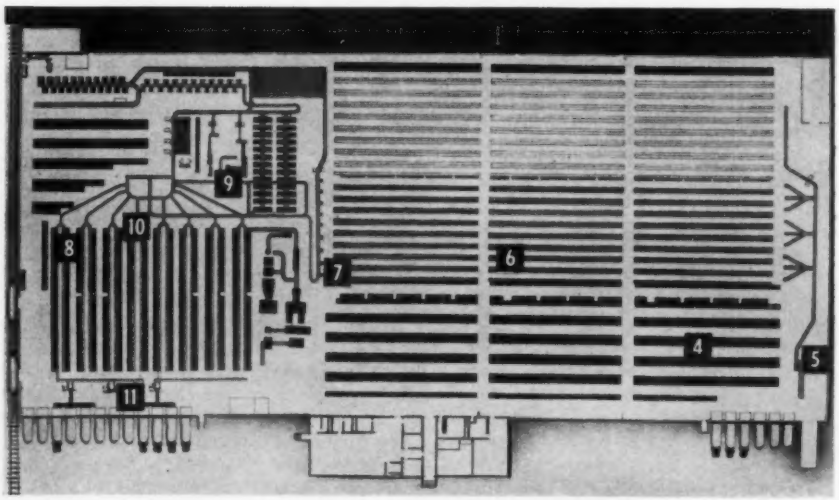
AUTOMATION TODAY

2

Another link in the integrated data processing system is the Cardatype. Prepunched cards having *Sold To, Ship To, Terms of Sale,* and *Part Number* data are placed in a card feed-and-read unit. Variable information including: *Today's Date, Order No., Quantity,* and *Shipping Date* are being set up on the auxiliary keyboard. *Customer's Order No.* and *Method of Shipment* are added through the typewriter keyboard. From the input sources the equipment produces a new IBM card for each shipping date on the order, and a typed copy of the order form. The order form master and a form for allocated quantities, called an *Invoice Variable,* are on special paper that can be used to produce shipping papers on a Multilith machine. Shipping papers and corresponding allocation cards are sent daily to Timken's central warehouse facility at Bucyrus, Ohio.

3

Warehouse and shipping center floor plan was designed to have bearings enter at the lower right for storage and emerge at the lower left in shipments to customers. Horizontal lines at right indicate storage area. Transfer station is located in center of packing and packaging area on left. Grouped around transfer area are departments for military, special, export, and service sales packaging. Packing benches for standard shipments are between transfer station and truck docks. Numbers refer to following photos.



4

Bearings that are to be kept in unbroken pallet lots are stored in racks. A clerk assigns a location to the incoming pallet and places an identifying punched card on the pallet. Lift truck, which can raise 3000-pound pallets 15 feet in the air, is used to handle loads into and out of storage.

WAREHOUSE ORDER PROCESSING

EFFECTIVE USE of automatic operations presents a challenge that goes beyond the scope of an individual function or department of a business. When the team approach is used in making an automation feasibility study, the nature and amount of automatic operations selected can be expected to do more for the over-all good of the business than when one function alone is represented in such an investigation. This is the systems engineering technique that considers each part and its effect on the whole, rather than each part as a completely separate entity.

An example of effective use of the team approach is evidenced by the integrated data processing system that has automated the central warehousing function of the Timken Roller Bearing Co. When management decided to look to more automatic operations in an effort to cut inventories, shorten lead time in making deliveries, and provide better service to customers, a feasibility committee was formed. This team consisted of representatives of the treasury, production, engineering, and sales functions of the company.

After a four-month investigation period the rec-

5

All bearing parts arrive at the shipping center on pallets. Pallets containing mixed items travel by conveyor to a pallet unloader. Machine automatically removes boxes and stacks empty pallets. Conveyor leading from unloader takes each box past an IBM key punch operator. Cards have been prepunched and printed with available location numbers, and are here punched with item number and quantity. A card is inserted in the end of each box and the controls for conveyor systems are set so that boxes will go to storage racks designated. Less-than-full-box units go to the bin storage area.

6 Branches of the box conveyor supply in-floor chain conveyors that take boxes through aisles between storage racks. Specially designed lift truck takes boxes from floor conveyor and places them in the location marked on the card. Operator takes card from box and verifies that *Pieces Per Box* and *Item Number* are correctly punched as shown on box label. Cards go to shipping office to be filed as a record of what items are stored where. Procedure for assigning boxes to locations by key punch operator is such that lift truck need make only one pass through the aisles. Item number locations are therefore random. Completely unrelated items may be found in adjacent spaces.

ommendations of the committee were presented to the board of directors and the go-ahead signal was given. One year later the system, which includes a new central warehouse building, was in operation.

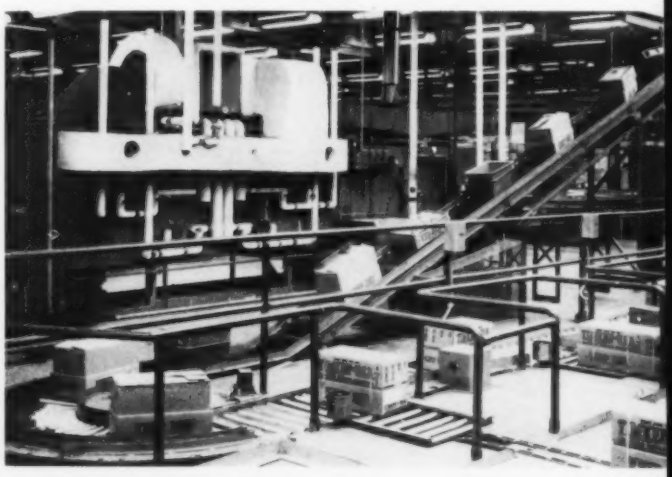
Before the new system was put into operation each manufacturing plant had its own shipping department. Orders received in Canton were routed to the proper plant. If it was a split order, one that requested several different sizes, the customer might receive bearings from several different plants. If one shipment was late, the customer had to hold the entire order until the pieces arrived. The central shipping center eliminates this problem since the entire order is shipped from this one location. No part of the order is shipped until the entire order is on hand.

The basic idea behind integrated data processing is to make records in such a manner that other related paperwork can be machine-made from the original record. This involves selecting a common language to be used by the data processing machines in the various stages of the flow of paperwork. Timken's feasibility committee chose punched cards as the common language and selected an IBM 650 computer as the core of the system. Business functions included in the system are: 1. Inventory control. 2. Production scheduling. 3. Storage of finished product. 4. Processing of customers' orders.

To head this operation at Timken's Canton, Ohio, headquarters a Sales Planning Dept. was formed with three sections to handle the major subdivisions of activity: Order Entering, Schedule Allocation, and Customer Relations. To provide these sections with daily summaries of the status of inventory, production, and unfilled orders, the computer is used. Punched card input includes cards that show yesterday's status for all items of manufacture, plus cards that show changes to be entered as a result of today's business and today's decisions. The computer makes the necessary additions and subtractions for all categories of all item numbers and produces a new set of cards that show today's status.

Another machine in the chain of paperwork is a Cardatype that prepares typewritten orders and punched cards representing shipments of customer orders. Cards produced are used as input data for the computer. Order form typed here is a Multilith master from which other copies are made.

As manufacturing schedules are completed at



7 Allocation cards received from the Sales Planning Dept. in [illegible]re sorted by date of shipment to show what materi[illegible]s [illegible] be packed each day. Allocation cards are used to select location cards from file for pallets, boxes and bin product needed to make a shipment. Location cards are marked with number of pieces to be shipped, packing station assigned, and packaging code number. Now called "picking tickets," these cards are sorted by location sequence and placed at heads of aisles so that midnight shift operators can pick the next day's orders in one pass down each aisle. Photo shows picked-product enroute to transfer station which is five feet above main floor.

8

Products coming from storage are in random sequence with respect to orders, but each unit has been identified with an order and a packing station. Attendants read picking ticket on incoming material and manually move item to conveyor leading to either special packaging, export line, service sales line, military packaging or directly to packing benches. Photo shows gravity conveyor branch lines fanning out to packing lines in foreground from elevated transfer station in background. All orders clear through transfer station except those shipped in same pallet-load as received for storage.

the various plants, pallet loads of bearings are shipped by truck to the shipping center. As Multilithed shipping papers and corresponding punched allocation cards are completed at Canton, they too are sent to the shipping center on these trucks.

At the shipping center about 100,000 square feet of floor space are used for storage. Three unit sizes are segregated into different areas. Less-than-full-box units are stored in bins arranged in item number sequence. Full boxes are stored in racks, and full pallet loads in another rack area. Each location is identified with a seven-digit number. Punched cards are used to keep track of the identity of the product occupying each location.

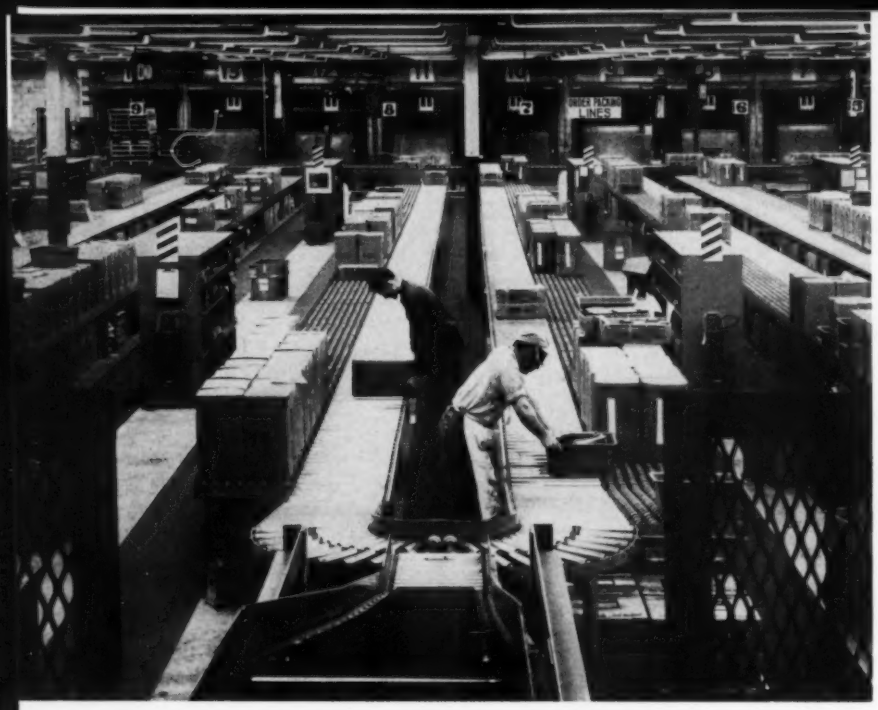
At the start of a day's receiving operations, punched cards representing all vacant locations in the racks are available at the receiving end of the warehouse. One of these cards is assigned to each unit and punched to indicate the item number and quantity contained in the unit as shown on the label thereon. When the unit has been placed in the rack designated, the punched card is removed and sent to the office. These location cards are filed so that allocation cards representing any given day's shipments can be matched with them, and the order picking operators can be instructed which units are to be pulled from storage for shipment.

Punched card "picking tickets" are sorted by location numbers so that order picking can be accomplished with one pass through the racks. Each ticket has been marked with a packing station and order number. As the units emerge from the storage area in a random manner they are switched to their destination at a transfer station that has multiple branches of the conveyor system. In this manner all product for a given shipping order ends up at the same packing bench.

To avoid confusion and delays inherent with trying to have all of these operations accomplished simultaneously, the handling steps are performed on a shift basis. When product is being received and put into storage, no orders are being picked from storage, and vice versa. By picking orders on the midnight shift, all material for a shipment can

9

Some items must be individually wrapped and placed in cartons prior to being packed in boxes. Automatic packaging machine can wrap and heat seal product, imprint Timken part number and nomenclature on carton, insert product into carton, and seal carton. Machine can package about 15,000 bearings on an eight-hour shift. Boxed bearings return to transfer station prior to shipment.



10

Each of the 16 packing benches is 100 feet long and is divided into four sections, making a total of 64 packing stations. During the midnight shift loaders arrange the product by order number on the benches so that packing, and loading of trucks can be accomplished on the next two shifts. Inclined conveyor in foreground leads from transfer station.

be assembled at a packing bench previous to arrival of the morning crew, so they experience no delay in obtaining the entire order for preparation for shipment.

Where special packaging of bearings is required the product is withdrawn from storage two nights before shipment to allow an extra day for rewrapping and packaging into individual cartons that are then boxed for shipment.

In addition to the advantages of machine reproduction of data the punched card system used has another plus factor that contributes to the efficiency of the system. Data are cross-referenced so that at any phase of the operation the product can be handled in the manner best suited to that phase, yet the cards can be machine sorted to provide the link to the next phase. This factor permits factory production to be scheduled in economic lot sizes, warehouse storage to be by "empty-rack" sequence, order picking to be by sequence of the aisles, and final shipment to be to customer's schedule. Data processing machinery's ability to quickly withdraw the information necessary for any frame of reference is an important key to successful operation.

Accompanying photos show details of parts of this warehousing system.

11

Banding, demagnetizing and weighing take place at shipping stations at end of packing lines. Portable conveyors can be placed inside trailers to make loading quick and easy. Pallet loads are placed into van bodies by lift trucks. Designed and built within a year's time, this centralized shipping facility now handles 95 per cent of Timken's bearing shipments.

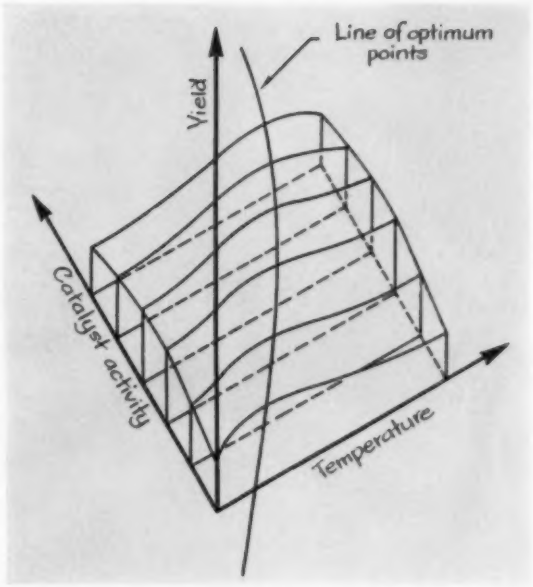


Fig. 1—Three-dimensional graph depicts shifting of an optimum point of yield on a response surface under the influence of changes in two input variables. Catalyst activity represents an uncontrolled input quantity whose variations may interact with changes in the controlled input, temperature, to move the point of maximum yield.

OPTIMIZING PROCESS OPERATIONS

BY AUTOMATIC EXPERIMENTATION

Most actual processes involve several input variables which are difficult to measure and whose effects on the output are hard to predict. The authors suggest a control means to optimize output by automatically experimenting with combinations of those input variables which are controllable. Complete equations defining input-output relationships are not required, nor must an operator determine desired changes and adjust set points of individual input controllers.

By **A. KERSTUKOS** and **R. I. VAN NICE**
New Products Engineering Dept., Westinghouse Electric Corp., Cheswick, Pa.

A BASIC PROBLEM in operating a process generally is to optimize some quantity concerning that process. Whenever a decision to optimize something about a process is made, it becomes necessary to determine how this may be done. Commonly, the process is studied on a small scale, such as in the laboratory or a miniplant. Various combinations of the process variables (temperatures, pressures, flow rates, etc.) are tested to determine which combination comes closest to meeting the objective. Often the results are considered sufficiently good to warrant the operation of a pilot plant or production plant.

For the simple case of one controlled and one uncontrolled variable, it is possible to visualize the optimization problem in terms of a surface in three dimensions, *Fig.* 1. This response surface will have, we assume, a peak value of the output quantity (yield) for each value of the uncontrolled variable (catalyst activity) as the controlled variable (temperature) is changed. The figure shows how the peak yield can change in location and value as the process drifts, following a line of optimum points on the response surface.

Controllers and Operators

The function of maintaining process variables at their desired values is usually delegated to automatic

Fig. 2—Demonstrator illustrates application of automatic optimizing controller to a simulated process. Unit is arranged so an operator can compete with the controller to see which can obtain the greatest integrated output over a given period of time.

controllers under the supervision of a human operator. As the process changes, for example, due to a reduction in catalyst activity, the operator may be called upon to change the set points of the controllers in order to compensate for the changes. The function of a standard controller is to maintain a single process variable at a desired level or set point as closely as possible. It is a closed-loop or feedback regulator device, which measures the variable to be controlled, compares its value with the set point, and actuates corrective measures if there is a difference. A controller must compensate for what might be called load variations, e.g., for a reaction chamber which is to be maintained at constant temperature, the controller must compensate for ambient temperature variations and reaction exothermic variations. Of course, the controller must have the correct sensitivity and dynamic properties to control with the desired accuracy, speed, and stability.

The essential nature of the operator's task is usually to optimize (either maximize or minimize) some quantity, though he may be unaware of this himself. Ideally, the operator would have in front of him an instrument indicating and recording the magnitude of the quantity in question. He could then readjust the set points of the controlled process variables, probably one at a time, observe the effects after the process settles down, and thus by a series of experiments determine the best settings. While the operator certainly can and does learn something about control of the process through experience, he does not have a complete understanding by any means. Quite likely he places more weight on recent data. His approach must be empirical, or trial-and-error, guided insofar as possible by experience, and yet it is apparent that he can be successful up to a certain point.

The limitations of a human operator attempting to optimize a process are many, so that even if we insist on simplicity in an automatic optimizing controller, it can still outperform the human. It can, for example, have a more certain memory, a more intelligent search method, and the ability to handle more variables simultaneously. Furthermore, it can be made faster and more diligent than the human. In the game of outguessing a process, human interest can soon flag, while an automatic controller will always play at its best, and does not experience frustration.

The untrained human operator suffers in comparison with an automatic optimizing controller because of two common errors. First, in determining move size, he may be either too bold or too cautious. Second, he almost invariably changes only one variable at a time. It is easily shown that such a strategy may fail for some response surfaces in which the variables interact. Of course, the human can learn by repetition and correct his faults, while the machine always follows its built-in strategy and does not benefit by repetition of a problem.

▸ Computer Controllers

General purpose digital computers have been suggested for the control of processes or even entire

plants. The most common concept of computer control is as follows: the pertinent variables affecting the process are digitized and fed to the computer. By following a specially-prepared program, the computer performs calculations and arrives at values of set points for the controllers. These digital values are used to actuate set-point adjustments. An operator supervises the computer and can, if necessary, take over control of the process manually. The information required to write the computer program includes relations between the process variables and the dynamic characteristics of the process and its equipment.

The reasons for which digital computer control has not become common are many. First of all, until recently the only medium and large-sized computers available were designed for business and scientific calculations. In addition to being expensive, these did not have the high order of reliability so important for process control, and required extensive modification to be used as control computers. Computers designed specifically for process control still suffer from their high cost; they will probably be justifiable only for complex systems and where other functions such as data logging can also be performed. Finally, any computer control which makes efficient use of the capabilities of the computer must use quantitative process data, perhaps in the form of equations. Difficulties and costs encountered in obtaining these data must be considered carefully in planning the application of computer control.

Optimizing Controllers

So far, then, we see that the conventional controller does not optimize, but merely regulates; and that a digital computer can optimize in principle, but there is a long road between principle and practice. A third method for optimizing is to use a controller which hunts a maximum or minimum. A practical optimizing controller cannot depend on having complete knowledge of a process. It must instead imitate the skilled human operator, and do so with a minimum of equipment so as to be highly reliable and economically justifiable.

Probably the best known example of a device which hunts a maximum is the signal-seeking automobile radio. It is similar in concept to so-called "optimalizing" control, as developed by Li and Draper at Massachusetts Institute of Technology. Such controls seem best suited to single-variable problems in which a continuous measurement of the output quantity can be made. Multiple-variable problems can of course be attempted by independent controllers on each variable. It is known, however, that a ridge inclined to the axes may be mistaken for a peak on the response surface.

Automatic Optimizer

An automatic optimizing controller has been developed, at Westinghouse Electric Corp., which automatically experiments with controlled variables to optimize the output. The development was called Automex because of its function as an automatic experimenter. The approach taken by Westinghouse has been that of making discrete steps in the values of the variables, rather than continuous changes. We may use a game analogy, in which an optimizing controller makes moves with the object of optimizing a quantity, while the process makes moves, i.e., it drifts, which tends to conceal the location of the optimum. The controller makes a move by changing one or more of the variables in steps of appropriate sizes, measures the resulting output, determines whether the move was a success or failure, and on this basis decides upon a next move. It remembers the value of the output after the last successful move, and uses this point as a base point. Depending upon the pattern of failures and successes, the direction and size of the next move are determined. The logical scheme for decision is called a strategy, just as it would be in a game; and part of the over-all strategy can be to change strategies during a game.

The strategy built into the machine was developed by Dr. Robert Hooke of the Westinghouse Research Laboratories. For a two-variable machine the strategy is as follows: Initially it changes one variable incrementally in its largest move size and measures the resulting output. By comparison with the initial value it decides whether the move was a success or failure, and hence whether the move was in the correct direction or not. Next, it changes both variables simultaneously, and again tests success or failure. Then it changes the second variable alone, then both variables, etc., and continues making decisions as to the proper direction of the changes.

Fig. 3—This printed circuit board is used in the demonstrator to simulate a two-variable process. Each contour is electrically energized to a potential corresponding to a value of the output. Re-positioning of a voltage probe in *X* and *Y* directions over the board reflects changes in the two input variables.

When a certain number of successive moves are all failures, the peak has been found.

These controllers will use solid-state elements insofar as possible and will be designed for utmost reliability. Their cost will be considerably less than that of digital computer controllers. The future of optimizing controllers in the process industries is believed to be bright as these industries continue to seek more and more automatic control to solve their problems. Automatic experimentation can be used to control almost any process now controlled by a human operator. In addition, it may be possible to develop new and improved processes exploiting such control. The most difficult requirement to be met is that the quantity to be optimized must be measurable or computable from measurable quanties.

▶ Control Demonstrator

An example of an Automex controller has been built as a demonstrator unit, *Fig.* 2, to show how a machine can seek a maximum of a function of two variables. This demonstrator also allows a human operator to compare his ability with that built into the machine. The demonstrator uses an analog of the two-variable process which is a contour map etched on a printed circuit board, *Fig.* 3. Each contour is electrically energized to a potential corresponding to the height of the contour, i.e., the value of the output quantity. The board takes the place of the usual chart on the bed of an XY positioner, and a voltage probe replaces the pen. To simulate the effects of uncontrolled variables, one can move the board around to some extent, thereby changing the location of the peak output point.

The human playing against the demonstrator has two control knobs, *X* and *Y*, which control the position of the voltage probe, though of course the process analog is not visible to him. All he knows about the process is the value of the output variable, presented as a meter reading upon demand (operation of a switch). Thus, he is in a situation comparable to that of the operator of an actual process who is fortunate enough to have an indication of output.

The best measure of comparison between a human and the demonstrator is taken to be output integrated over a given period of time. In other words, the winner must find the peak as quickly as possible and thereafter remain in its vicinity. The same criterion of excellence could be applied to the control of an actual process. The results of a machine-human comparison are not unexpected. At the beginning, the human is inferior, but on repeated tests he learns rapidly and may readily surpass this machine as it is constructed. However, it would be possible to speed up the machine so that it would always win. The demonstrator simplifies the actual control situation considerably. The introduction of random variations in the output or of more than two variables would quite likely give a machine a great advantage. As time goes by, the human loses interest in the game and would probably need to be given considerable incentive before he would consent to play it for a 40-hour week.

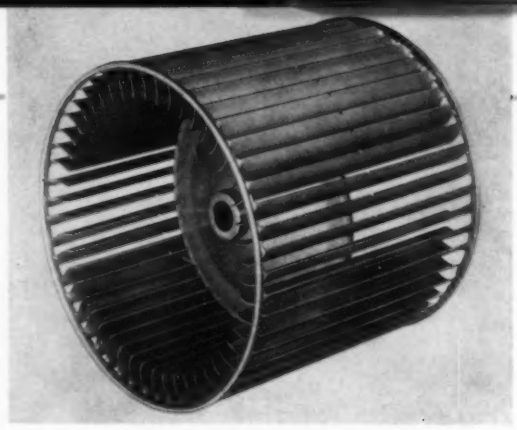
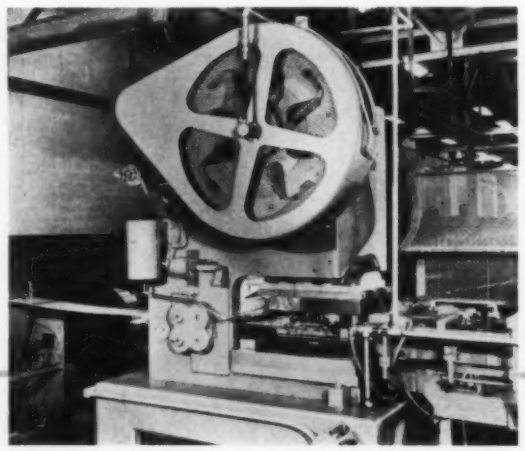


Fig. 1—Mayne blower wheel design is such that it can be fabricated by methods that are readily automated.

BLOWER

PRODUCT design and process engineering complement each other in the quest for industrial achievement through automation. An example of what can be accomplished when these two engineering specialties are closely co-ordinated is the design of a blower wheel, developed and patented by Mayne Products Co.

This assembly *Fig.* 1, is made of a stamped cage, a hub, and a center disc. Cages are made of sheet steel that is fed from a coil into a punch press which pierces, lances, and forms the blower louvers, *Fig.* 2a. A completed length of stamping is assembled to a second such length of stamping, *Fig.* 2b, and the laminated sides are welded together. This weldment is rolled into a circular shape, *Fig.* 2c, and the ends are welded to form the cage. Flat margins of the cage are rolled to form a bead that adds rigidity to the rims. The operation is automatically performed on a special machine developed by Mayne



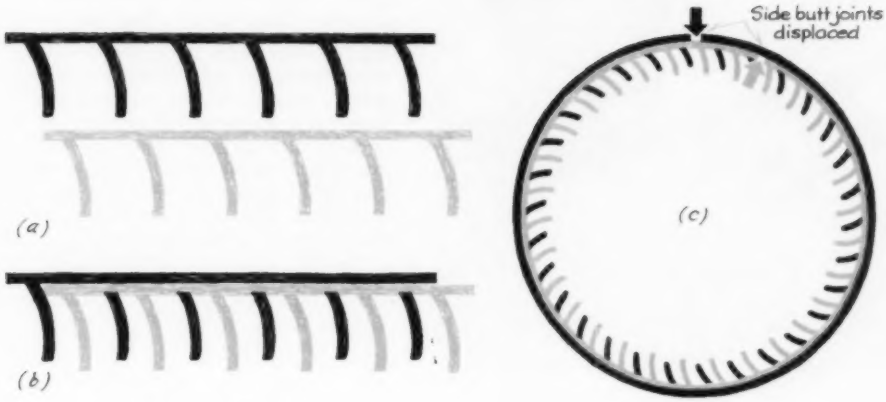


Fig. 2—Side views show blower cage stampings *(a)* which are interlaced and resistance welded *(b)* and rolled into circular shape *(c)* of cage. Longitudinal placement of interlacing is such that side butt joints are displaced allowing ends to lap for welding that secures rolled shape.

WHEEL PRODUCTION AUTOMATED

Products. The hub and center disc subassembly is placed in the center of the cage and expanded in a hydraulic press to secure the center disc to the cage.

The resultant product is an item that can be made and sold in 1958 for a lower price than it was possible to do in 1939. This saving is accomplished despite higher wage rates and material costs.

One installation that produces an average of one blower wheel every 35 seconds is in a shop of the Airtemp Div., Chrysler Corp.* Equipment used is flexible in setup so that 12 different diameters of wheels are made on the same line.

A press and a welder manufactured by Precision Welder & Flexopress Corp., *Fig.* 3, achieve a high degree of automation in the first operations of the blower wheel manufacturing process. This company specializes in integrating high speed stamping and resistance welding operations. A 75-ton Precision Flexopress is supplied coil stock through its integral feed mechanism. Louvers are formed at the rate of 120 strokes per minute.

Completed stamping moves three feet and is positioned ahead of the welding station. The second stamping is then interlaced with the first and both are indexed to the welding station. Two specially-tooled standard 30 KVA Precision bench welders automatically index and join the two stampings with 38 welds. Adjustable limit switches automatically start an electronic timer which sequences the welding and indexing. Integrated stamping and welding enables the two machines to be accurately sequenced to get high production.

This blower serves as another example of the advantages to be gained by designing a product in such a way that it can be fabricated by methods that are readily automated.

*"Part Redesign Aids Production." AUTOMATION, Vol. 4, No. 7, July 1957, page 45.

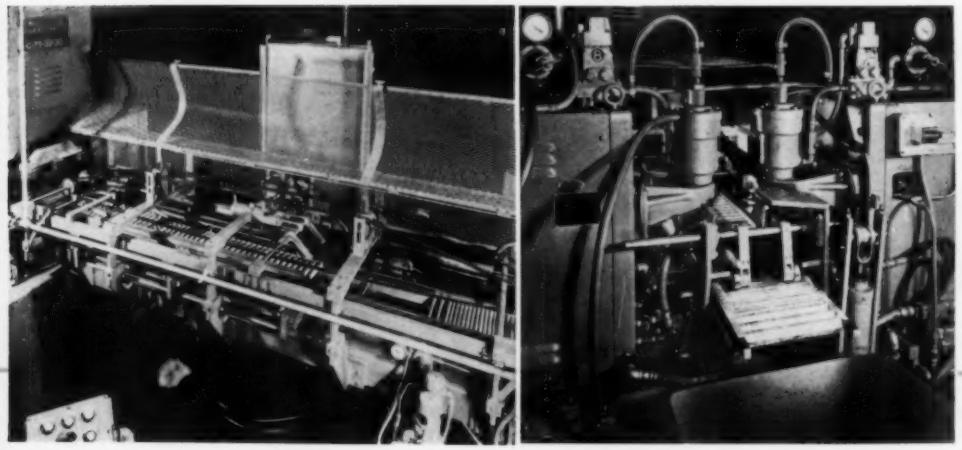


Fig. 3—Precision Flexopress forms louvers in cage stampings. Transfer mechanism conveys, interlaces, and positions two stampings. Precision welders join the stampings with 38 welds. Integration of press and welder achieves production economy.

Fig. 1—Field setup of portable concrete batching installation. Aggregate and cement are automatically weighed and discharged into a mixer where water may be added. Waiting trucks receive mixed batches on pushbutton command. When project is finished, equipment can be moved and set up in other locations.

AUTOMATIC BATCHING SYSTEM

COMBINES FLEXIBILITY AND PORTABILITY

By **ALTON G. BALE Jr.**
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INDUSTRIES in an ever-widening range of activities are securing the benefits of cost savings, accuracy, and safety of operation inherent in use of automatic batching equipment for bulk ingredients. Products as diverse in nature as concrete, food, asphalt, ceramics, beverages, and foundry sand are being formulated more efficiently with this type of equipment.

A previous limitation to broader adoption—namely, that automatic batching systems have been available only as permanent plant installations—is disappearing in some areas. A concrete batching system recently offered by the L. Burmeister Div. of Chain Belt Co., exemplifies the new trend toward greater flexibility of use of such equipment.

Utilizing controls designed and built by Wisconsin Electrical Mfg. Co., the system, *Fig.* 1, incorporates latest batching equipment technology in an arrangement that is transportable from job to job. When its purpose in a given area has been served, the equipment can be moved and set up in other locations.

The system automatically weighs cement and as many as four aggregate materials, discharges them into a mixer, and adds the proper amount of water for a desired mix. Water addition can be omitted for dry mixes. Trucks, driven into position under the mixer, receive the predetermined mixture upon pushbutton command from the driver.

The system, *Fig.* 2, includes aggregate, cement, and conveyor units in addition to a mixer. The aggregate unit batches each aggregate material in sequence. Desired weights are predetermined by settings of electrical controls on a remote panel. As an individual material flows from its bin into the aggregate weighing hopper, an electrical signal proportional to its weight is generated in a transistorized sensing unit associated with a weigh scale for the hopper. This signal is continuously compared with the signal preset on the control panel.

When the signal from the sensing unit indicates a weight in the hopper approximately 80 per cent of that desired, the bin gate (of split clamshell construction) closes under the action of a solenoid actuated air cylinder. By the time the mid-air material has dropped into the hopper, the weight might be 95 per cent of the preset weight. After an adjustable time delay to allow falling and weighing of the material in mid-air when the gates close, a gate "chatter" action begins.

Chatter is produced by causing the gate to open and close rapidly. Thus, small "bites" of material, several pounds each, are dropped into the aggregate weighing hopper and their weights are sensed. The control has been designed so that the closed time of the gate chatter cycle is adjustable to permit an individual bite to fall in the hopper and be weighed before the next bite is taken. Extremely

accurate final weights—within 0.1 per cent of those desired—can be obtained by this chatter action.

The control automatically selects the second, third, and fourth aggregate materials in sequence, repeating the operations performed for the first material. While the aggregate material is being batched, cement is batched in a similar manner by the cement batching machine.

Material from both batching machines is discharged to a common holding hopper, and both batching processes are automatically recycled to weigh out new product in the weighing hoppers. When an operator or truck driver pushes a button and dumps the material into a truck, the additional batches of aggregate and cement retained in the weighing hoppers are discharged automatically into the holding hopper, and rebatching commences automatically.

Features of Control

Control design is such that failure of any control element will almost always interrupt the flow of material rather than allow an excess of material to be batched. This feature is especially important when dealing with expensive materials such as cement.

In case of power failure, the bin gates will close automatically and stop the flow of materials. When the power is restored, there is no loss of sequence and no batch weight error. However, under some circumstances it may be necessary to manually finish the interrupted batch—provisions are included in the control for this contingency.

The hopper weight sensing units employ transistors instead of more conventional vacuum tubes. Substantially improved reliability is the result. Low replacement rates, and hence low machine downtime, are thereby secured.

The control equipment contains provision for electrically checking to determine if the batched material weights fall within preset tolerances of the original set weights (an out-of-tolerance weight can exist if the scale beams or rods are accidentally struck, or if a bin gate sticks in an open position while batching). If the weight of a material falls outside its preset tolerance the machine is automatically stopped. Lights on the control panel indicate whether the weight is under or over, and identify the material involved.

Comparative Performance

When not automated, batching of aggregate and cement is usually performed in one of two ways. In one method, an operator pulls hand levers to actuate the bin gates, at the same time watching a dial or beam scale to determine the point at which to close the gates. Accuracy of batching by this method is entirely dependent upon the skill and attention of the operator.

In the second method, which is semiautomatic, an electrical cutoff effects closing of the gates. However, the operator must still guess the amount of free-fall, or material interrupted in mid-air, so he can allow for it in setting the cutoff. Unfortunately, aggregate free-fall varies considerably from batch to batch and between different materials. While this method is better than the manual method, it is still affected by operator judgment, and is not particularly accurate.

The automated setup described requires only a part-time supervisor whose presence in the vicinity is usually required anyway. Thus, the labor of two men—one for the aggregate machine and one for the cement machine—can be saved. Accurate batching, with no loss of time, is also assured by the automated setup.

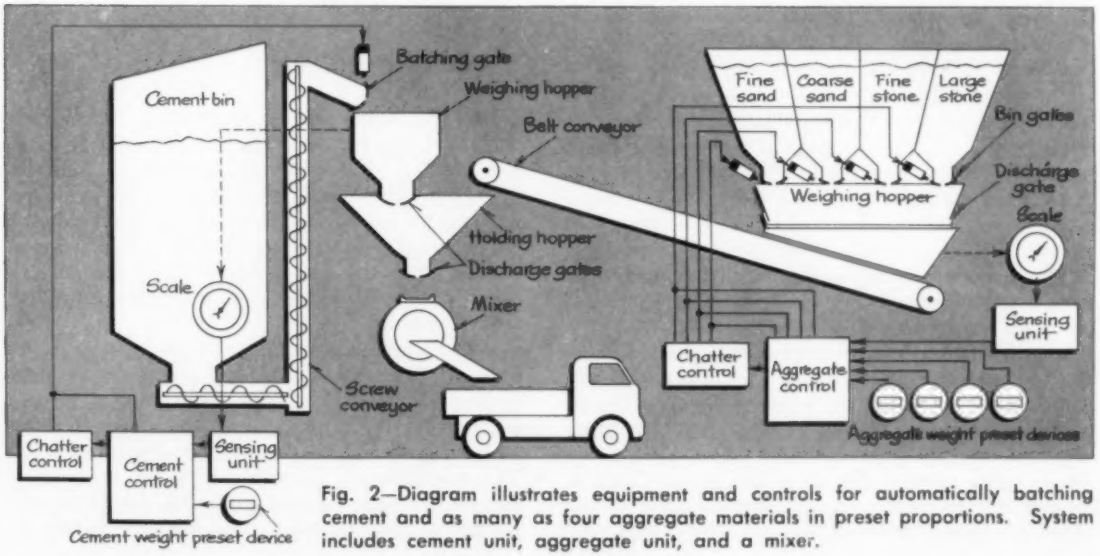
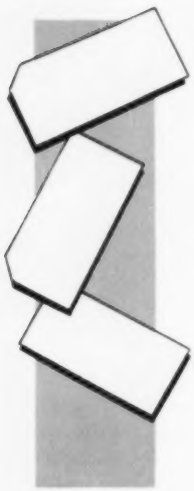


Fig. 2—Diagram illustrates equipment and controls for automatically batching cement and as many as four aggregate materials in preset proportions. System includes cement unit, aggregate unit, and a mixer.



CARDS CONTROL MACHINE AS

TRANSFORMERS SENSE TABLE POSITION

Repetitive accuracy of positioning is a critical requirement in the production of many parts. Compressor casings for J-79 jet engines are a good example; several separate passes may be required on each of more than 200 holes. Sensing of table position with differential transformers and use of punched card control give the machine described in this article accurate, automatic, angular positioning to one second of arc.

ACCURACY of positioning in machine tools can be no better than the accuracy of the system used to sense positions and the accuracy with which positioning commands are given. Requirements of close tolerances and rapid changes of product design, among other reasons, have led producers of modern aircraft components to adopt progressive developments in accurate sensing systems and flexible but accurate command media. One of the areas where such adoption has been important is in the machining of casings for J-79 jet engine compressors. These casings are open end cylinders requiring multiple machining operations for each of about 250 holes located in the wall of each casing. The number of times which a single part must be accurately positioned thus becomes so large that manual cranking of an indexing device must be painstaking and slow, but still can result in a great many errors.

Superior Machine & Engineering Co. has built a unit, *Fig.* 1, to combine accurate position sensing and punched card control for machining operations on jet compressor casings. The sensing system is a unique vernier arrangement using differential transformer heads and programmed voltages to read table position to one second of arc. The machine has two columns mounted on a base and joined by an overhead bridge. This construction gives high rigidity for the two vertical slides, which are power-driven, and each of them travels up and down in guides on its column. Each vertical slide carries three horizontal spindle slides and their drive.

A compressor casing to be machined is clamped on an indexing worktable which is mounted on the machine base. This is a standard type of table, *Fig.* 2, available from Superior. Over-all accuracy of the system is ±2 seconds of arc and the table repeats positions automatically to one second of arc —in other words—closer than one millionth part of a circle. This is an absolute positioning system in which all points are measured from a zero reference point rather than from a preceding point; thus, accumulation of errors is avoided.

▸ Table Positioning

Indexing of the table is obtained by the combined actions of two servos, a rough position servo and a fine position servo. Rough positioning is controlled by a 360-degree wire-wound potentiometer, which is mounted to the underside of the rotating table. By means of a resistance balancing network in connection with the potentiometer, the table can be rough positioned within 10 minutes of arc from the desired point.

When rough positioning is finished, the fine positioning system takes over and completes the positioning of the table. The fine position servo is controlled by a vernier system which uses 15 differential transformer heads and 360 armatures, *Fig.* 3. The armatures are mounted on the circumference of the table and are placed with one degree between centers. The differential transformer heads are

Fig. 1—Six-spindle machine for performing multiple machining operations on holes in jet compressor casings is controlled by cards. Workpiece is automatically positioned by indexing table which is accurate to one second of arc.

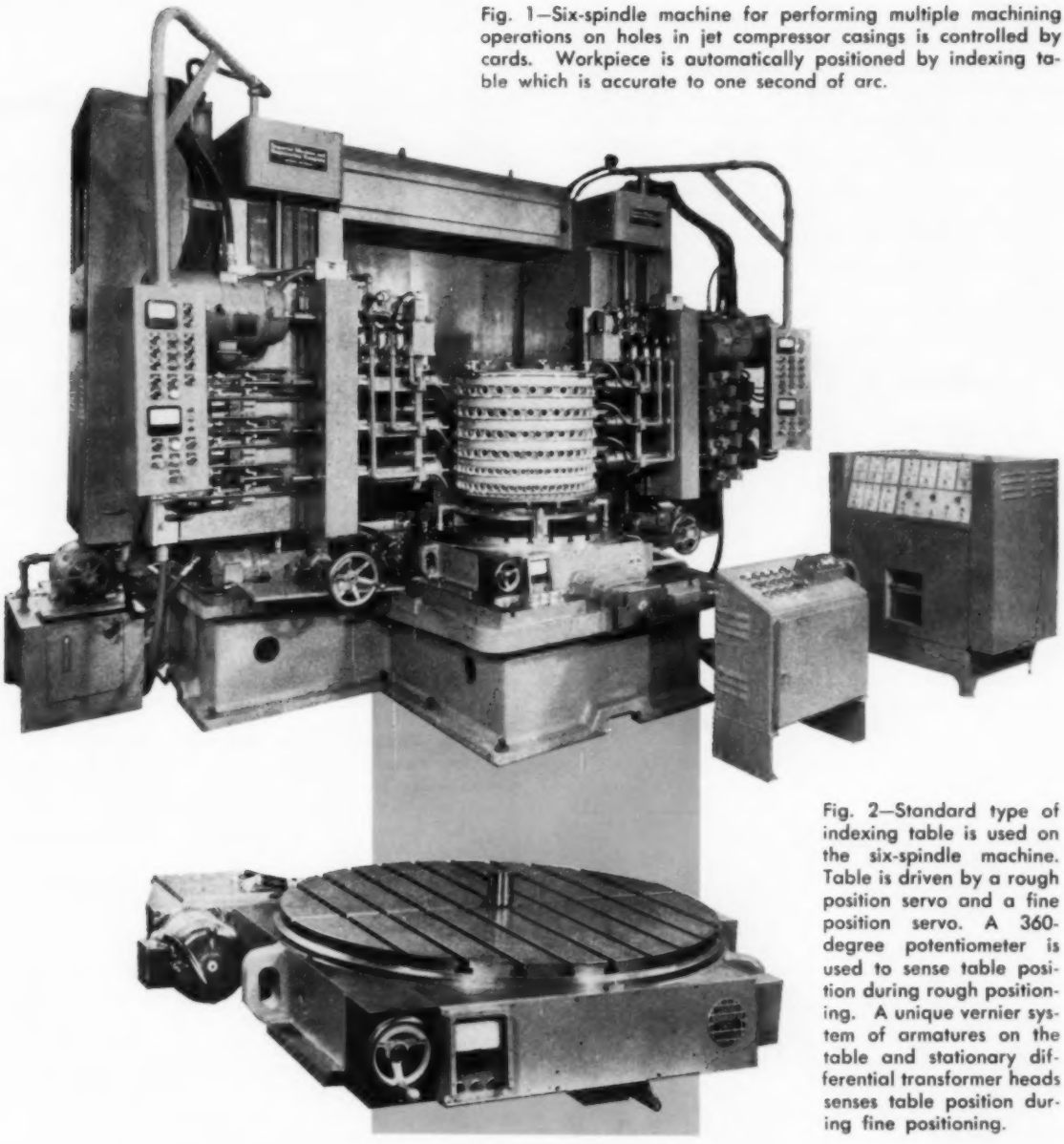


Fig. 2—Standard type of indexing table is used on the six-spindle machine. Table is driven by a rough position servo and a fine position servo. A 360-degree potentiometer is used to sense table position during rough positioning. A unique vernier system of armatures on the table and stationary differential transformer heads senses table position during fine positioning.

placed on the base of the table in such a manner that when an armature is exactly in line with one of the transformer heads, another armature will be 4 minutes out of alignment with the next transformer head, another armature will be 8 minutes out of alignment in the same direction from the succeeding head, etc.

Each differential transformer head has an exciter coil constantly energized by a 6 volt, 60 cycle, alternating current source. Two pickup coils in each head are wound and connected in such a way that the voltages induced in them by the exciter are 180 degrees out of phase. The armatures on the table pass between the exciter and pickup coils and affect the balance between the voltages induced in the pickup coils. Only when an armature is centered with respect to the two pickup coils of a head will the output of that head be a zero voltage. When an armature is displaced from the center of a head, the output voltage will be in proportion to the amount of displacement. Because of the vernier arrangement in which the transformer heads are placed, the table can be positioned accurately to every fourth minute of arc by moving the table to the point where a zero voltage is obtained from a certain transformer head. When 239 additional output voltages are considered for each head, the table can be positioned to every second of arc by moving the table to the point where a certain one of the 240 voltage outputs is obtained from a certain transformer head. The proper voltage

for a desired position is introduced in an error detector by selector switches, and the output of the selected transformer head is nulled against this programmed voltage.

Over-all absolute positioning accuracy of the system is plus or minus 2 seconds of arc, and a previous position is repeated to one second of arc. Since no screws, gears, counters, or wearing parts are used in the sensing system, and since there is no physical contact of gaging elements, permanent accuracy and no necessity for adjustment are expected. This unique system was developed by Superior in co-operation with Cleveland Instrument Co.

▶ Positioning By Card

For operation under punched card control, cards are made up as indicated in *Fig.* 4. Dimensions are taken from the part drawing, listed on a planning chart, and converted to machine commands on punched cards. The cards designate the spindle to be used, spindle speed, advance and retraction rates, height of the spindle above the index table, and position of the table in degrees, minutes, and seconds. All operations are punched twice on a card for a built-in self-checking feature.

When a card comes into reading position in the Remington Rand card reader, pins make contact through the punched holes to establish a contact pattern representing the coded commands. In the table positioning phase, this contact pattern controls a digital-to-analog converter which uses stepping switches to establish rough and fine position reference inputs. The system is monitored by comparing the control pattern in the converter with the duplicate pattern of contacts on the card. Unless the two patterns match, the positioning cycle will not start. Numerical indications of the commands also are visible on the control panel so that the operator can check them.

Rough position reference input is compared to the signal from the potentiometer which roughly indicates actual table position. This comparison is made by a rough position error detector. The error signal from this detector causes the rough position servo to drive the table in the correct direction to reduce the error. When the position error is reduced to 10 minutes, a range discriminator switches operation from the rough to the fine position system.

Fine position reference input is compared to the signal from the vernier arrangement of differential transformers which indicate table position within one second of arc. This comparison is made in a fine error detector which controls the fine position servo. When fine positioning is finished, the table

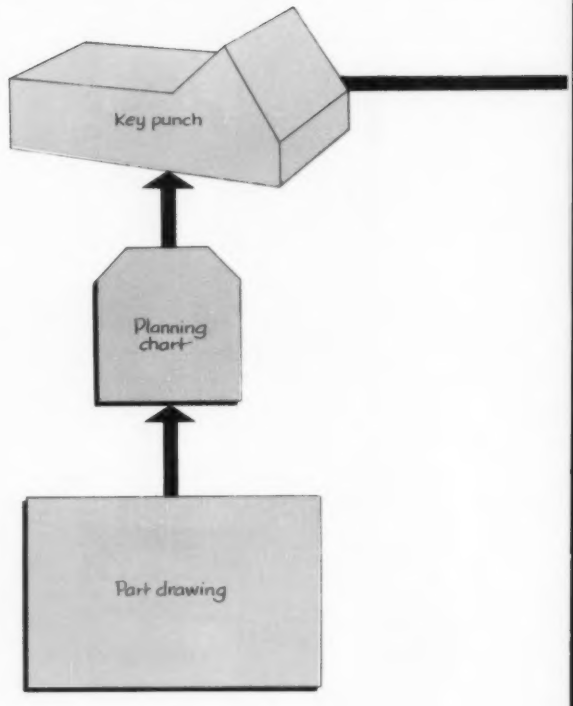


Fig. 4—Block diagram indicates steps from reading of part dimensions on drawing to fine positioning of worktable for machining operation. Cards are used as control medium in this version but system could be designed to use tape.

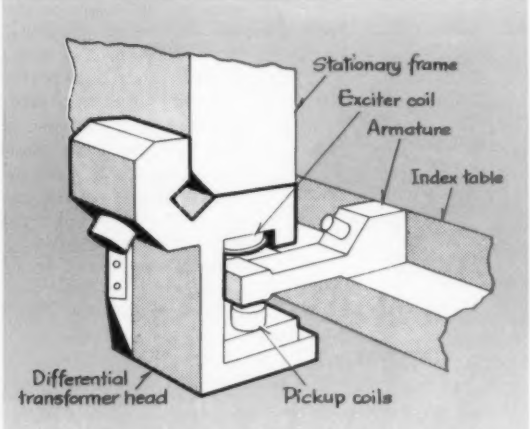
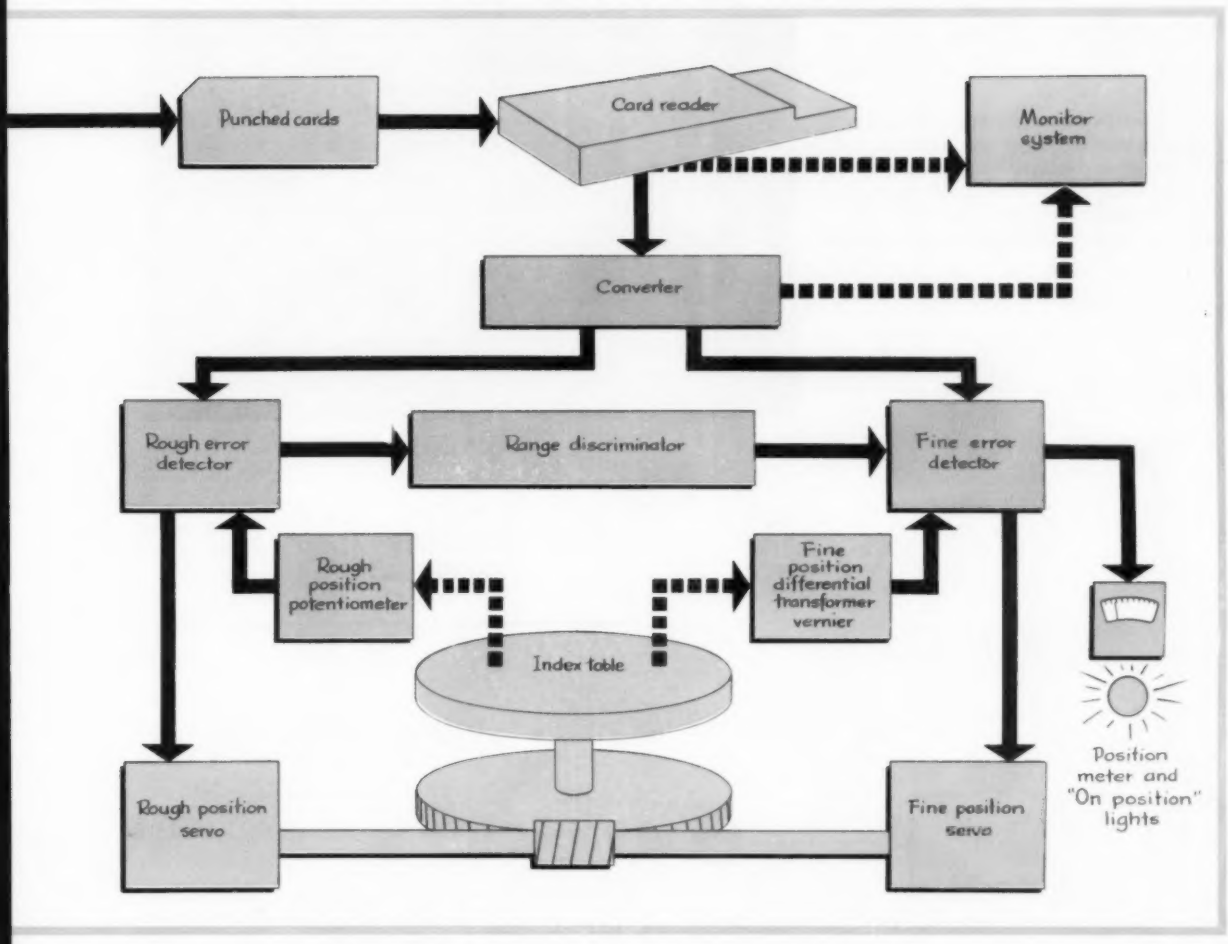


Fig. 3—Armatures for fine position sensing are mounted on the table on centers one degree apart. Fifteen differential transformer heads are mounted on the table frame in a vernier arrangement which centers an armature on succeeding transformer heads for each 4 minutes of arc. Each differential transformer head includes an energized exciter coil and two series opposing pickup coils. When an armature is centered on the head, the voltage output of the head is zero.



is automatically clamped, interlocks energized, and *On position* lights signal completion of positioning cycle.

Why Cards

The designers of this system weighed carefully the relative merits of cards and tapes. Tape systems were felt to have a considerably lower initial cost and the advantage that a tape cannot be mixed up. But punched card control was felt to have the advantages that cards are readable without reference to codes; that operation of the readout system is fast; that any card may be removed without requiring a new set; and that engineering changes may readily be made on individual cards. It was also felt that cards could be used because of the built-in monitor and system interlocks which mean that sequence of the cards is not hypercritical.

Machining Operations

In the setup shown, three sizes of holes are machined. The largest holes are in the two top rows of holes. The top spindle on each vertical slide is tooled for machining the largest holes, so that two separate tools are available for these holes without tool changes. The middle size holes are in the two center rows of holes, and the middle spindle on each vertical slide is tooled for them. The bottom spindle on each vertical slide is tooled for the holes in the bottom two rows of holes. In a typical setup for rough machining, the spindles on the left vertical slide bore, counterbore, and chamfer; spindles on the right slide use generating tools to backface, backchamfer and face the holes.

Because centers of holes in different rows are not lined up, only one spindle actually cuts metal at any one time. Each spindle has a separate rheostat for setting of its speed, and speeds are infinitely variable from 500 to 3000 rpm. Speeds are automatically determined by commands from the control cards. Advance and retraction of each spindle is determined by its own hydraulic cylinder. Each spindle can thus be advanced and retracted at its own rate as called for by the control card. As soon as a spindle reaches retracted position, a cone clutch automatically disengages its drive, so that each spindle rotates only when out of the retracted position.

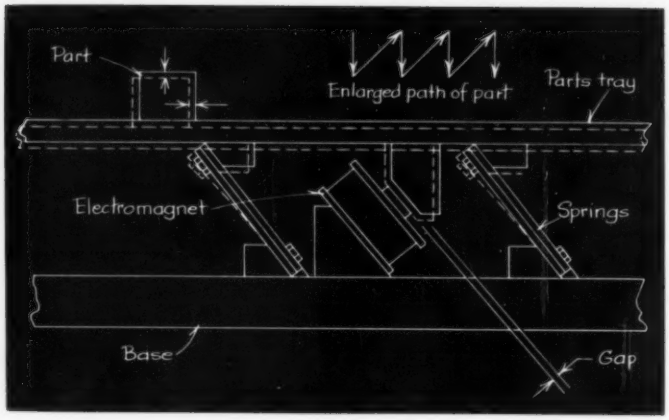


Fig. 1—Sketch illustrates advance of parts by intermittent action of an electromagnet. First vibratory feeders had a straight-line track as shown and were used mostly for bulk materials. Selection or orientation of parts for position were generally omitted.

MACHINE FEEDERS—2

By KENNETH R. TREER
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THERE IS no universal parts selector which can be used for all feeding jobs at all rates of feed. To determine what parts selector will perform a specific job, the person making the decision must know the general types available and factors in their application. In an earlier article* five basic types of parts selectors were discussed: Rotary ring, rotary disc, rotary drum, rotary agitator, and elevator. Five more commercially available standard types are discussed in this article: Vibratory, oscillating box, oscillating blade, barrel, and pin. A few special selectors are also sketched although

*K. R. Treer—"Applying Parts Selectors", AUTOMATION, Vol. 4, No. 7, July 1957, page 40.

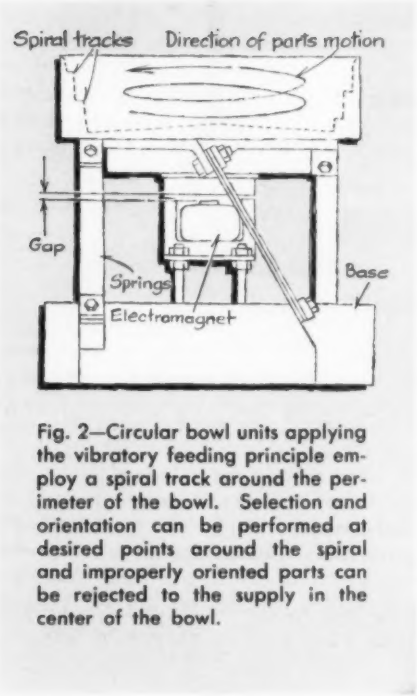


Fig. 2—Circular bowl units applying the vibratory feeding principle employ a spiral track around the perimeter of the bowl. Selection and orientation can be performed at desired points around the spiral and improperly oriented parts can be rejected to the supply in the center of the bowl.

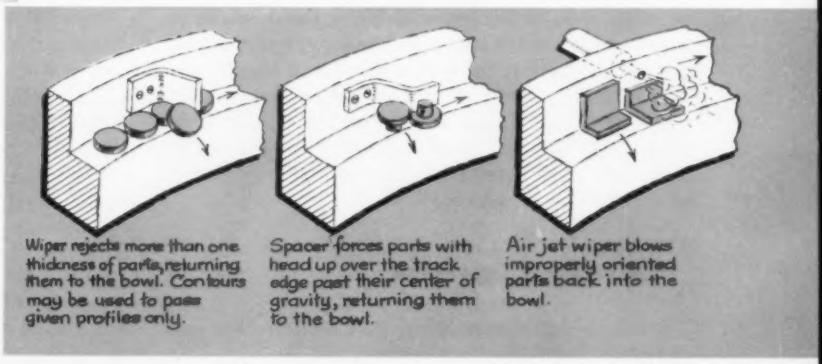

Wiper rejects more than one thickness of parts, returning them to the bowl. Contours may be used to pass given profiles only.
Spacer forces parts with head up over the track edge past their center of gravity, returning them to the bowl.
Air jet wiper blows improperly oriented parts back into the bowl.

Fig. 3—Shown are a few of the arrangements which may be used on the track of a vibratory feeder to select or orient parts for position. Selection of the particular method for a specific part must be based on consideration of the characteristics of that part.

Parts selectors are devices which hold a quantity of parts, perform one or more orientations or selections of position, and discharge them to tracks for use in machines of all types. This article continues a discussion in which the author describes basic types of parts selectors, factors in their application, and manufacturers that build them.

FEEDING DISCRETE PARTS

VIBRATORY • OSCILLATING BOX • OSCILLATING BLADE

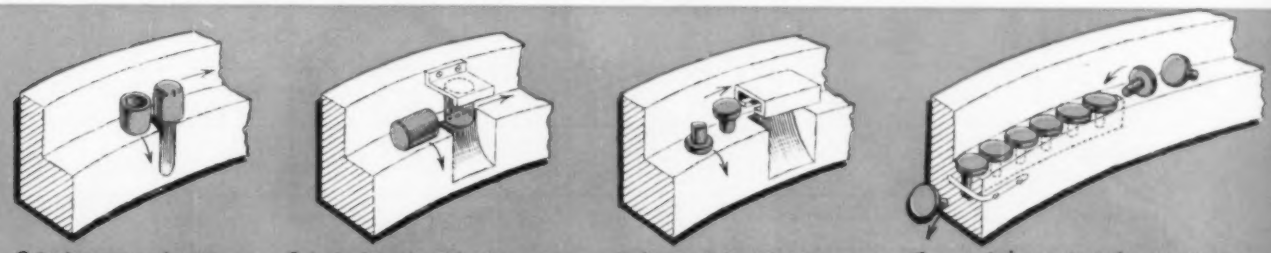
ROTATING BARREL • PIN • SPECIAL SELECTORS

they are not known to be commercially available as standard units.

The importance of choosing a parts selector of a type offering the highest degree of natural selection for a given size, shape, or other characteristic, cannot be overemphasized. Some types of parts selectors work well for more varieties of parts than other types of parts selectors, but any conversion of a parts selector from feeding one basic part shape or size to feeding another part must involve a certain amount of engineering, grooming, and other costs. The original planning involving a parts selector should consider not only the most efficient feeder for the given part, but also the probability of any part design change, the availability of conversion parts and service, stability of the equipment source, etc.

▶ Vibratory Selectors

"What makes the parts go?" is still a common question about vibratory feeding. *Fig.* 1 illustrates the basic elements and operation of a vibratory feeder. The parts being fed move along a spring-supported tray or track. The tray is repeatedly pulled down and back away from the part, by an electromagnet or other actuator, faster than gravity



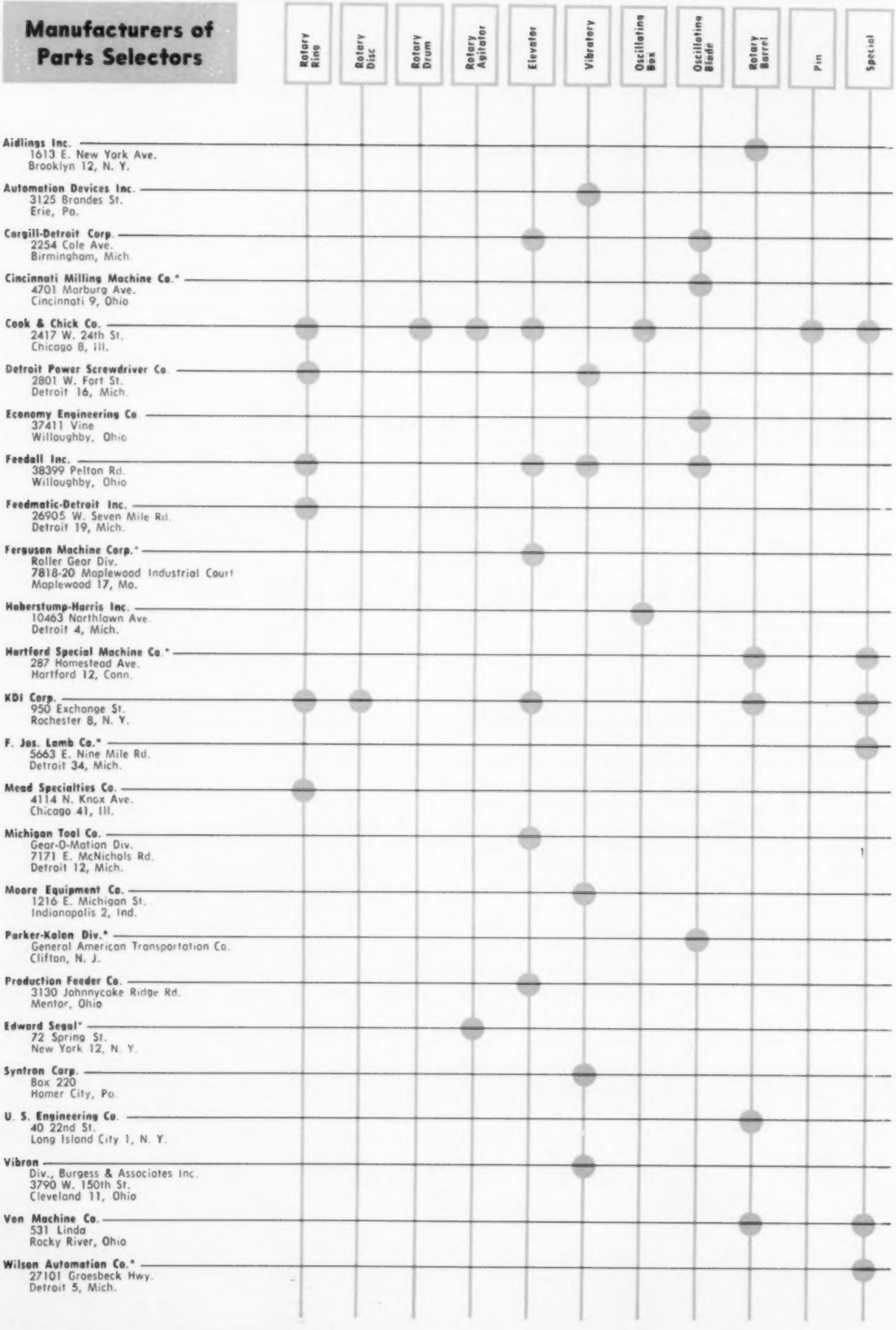
Cutout passes parts with sharp, open end down, but lets rounded cup end fall back into the bowl.

Cutout with a hood holds parts standing up as they pass over gap, while parts with horizontal axis drop back into bowl.

Rails over cutout retain parts with head up, permit parts with head down to drop back into the bowl.

Two orientation methods for use with long, headed parts. Slot lets parts hang by heads. At discharge tube, arm trips parts to fall head first if desired.

Manufacturers of Parts Selectors



*Selectors made primarily for own equipment rather than for open-market sale.

causes the part to drop. As a result, the part falls on the tray a certain distance forward from its previous position. When the electromagnet is de-energized, the springs return the tray to its original position, moving the part toward its destination. Repeating this cycle 3600 times per minute causes the part to move forward in an apparently continuous straight-line motion, although the path the part follows actually has a saw-toothed shape.

Varying the magnitude of the vibration will vary the distance which the part will travel per cycle. For small parts feeders this is usually 0 to 0.030 inch. When the frequency of vibration remains constant, variations in the amplitude will be reflected in the rate at which the part will travel forward. With horizontal feeders a continuous range of rates from zero to the maximum inches per minute may be obtained by varying the amplitude. When parts are being carried up an incline, the flow rates obtainable drop sharply to zero below a cutoff point determined by part weight, friction, and other factors. The spring design must be adjusted to allow for tray and part weight and to obtain a natural frequency slightly higher than the magnet frequency.

The earliest use of vibratory feeders was for the feeding of bulk materials such as sand and gravel. These were in-line feeders moving materials from a bulk hopper to deliver them at controlled rates into processing machines or packaging equipment. Such feeders were later used to move parts in bulk, but provision for orientation of individual pieces in order to make a parts selector from a feeder was generally omitted until the innovation of spiral tracks around a hopper bowl to permit easy return of misaligned parts back to the bowl supply, *Fig.* 2.

Today's techniques make vibratory feeding one of the most versatile means of automatically feeding parts. Selection and orientation arrangements covering a great many combinations of parts shapes, materials, and sizes are available, *Fig.* 3. The most reliable means of selection (the passing of properly oriented parts while rejecting improperly oriented parts) is a mechanical one. Usually profiles are employed through which properly oriented parts will pass. Selections may also be made by means of sensing devices such as photocells which can trigger a rejection device. Air jets are used to reject improperly oriented parts where different dimensions of the part have a substantial difference. Orientation (changing part positions by gravity action or mechanical devices to properly align them) is frequently obtained through the shape of the track in the bowl or by the shape of the discharge gate. Obviously, orienting rather than merely rejecting improperly oriented parts is desirable when attempting to reach a high rate of parts feed.

To prevent falling behind, the rate of feeding should be adjusted to supply parts faster than they are actually required. However, when a vibratory feeder supplies parts faster than they are used in the succeeding equipment, the parts accumulate in the discharge track and the bowl track. In many cases this blocking of the track against the pressure of the oncoming parts from the bowl will cause parts already selected or oriented to change positions and cause a jam. The next step is to prevent the jam. Two primary methods are used to prevent jamming: Diversion and intermittent feeding. Where possible, the accumulation of parts in the track is used to divert additional parts back into the bowl. Where diversion of parts is not practical, the feeder may be run intermittently under the control of a sensing head in the track. Photocells and proximity switches are commonly used sensing units.

Other factors to be considered in vibratory feeding include part weight, material, friction properties, size, shape, quantity of parts which must be stored, and rate of delivery required. Weights of parts which have been fed in a practical manner with vibratory feeders range from a few grams to many pounds. This weight range covers such items as stamped foil labels and 2½ by 4 by 4-inch steel slugs.

Materials which can be fed by vibratory means include nearly any solid and range from sponge rubber to glass vials. But, the feeding rate for a very flexible part will be less than for steel, highly brittle fragile parts will be subject to breakage, and very fine surface finishes may be scratched. These problems may be minimized by lining the feeder bowl with plastic or flock coatings.

Weight of the part, contact area between part and bowl, and coefficient of friction between the part and the bowl have important influences on the feed rate. A bearing ball, for example, will not feed up a bowl ramp at all. Bearing balls are fed by placing in the bowl flat slugs of steel somewhat larger in diameter than the balls. The slugs push the balls up the track and are rejected at the top of the ramp by means of selective wipers.

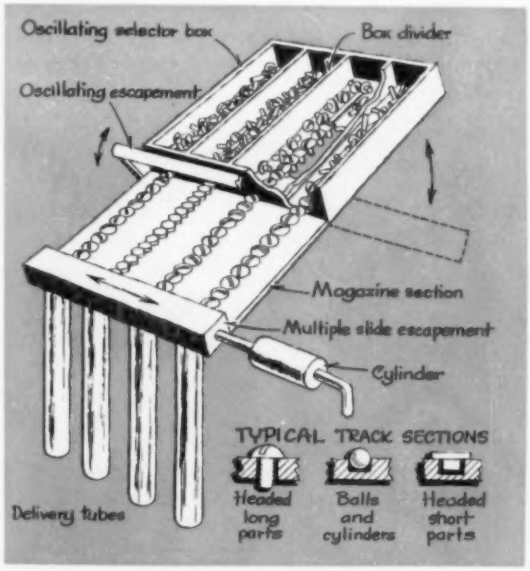


Fig. 4—Oscillating box type parts selectors are commonly used to feed screws, nails, rivets, and balls. Several tracks can be fed simultaneously and several types of parts can be fed at the same time from a single oscillating box.

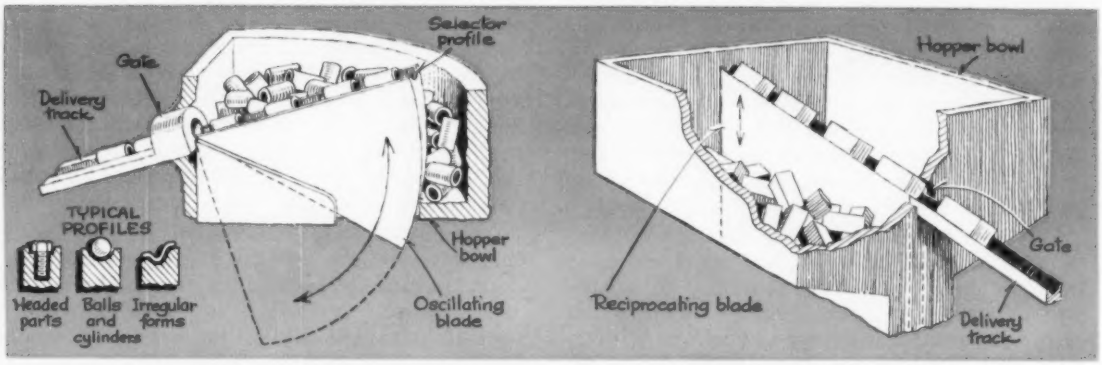


Fig. 5—These examples of oscillating or reciprocating blade parts selectors indicate how a contoured blade is passed through a mass of workpieces to selectively pick up parts. The properly oriented parts which the blade picks up are discharged by gravity to a delivery track.

Sizes of parts which can be fed are limited on the low end of the range to dimensions which can be practicably controlled mechanically. Washers only 0.004 to 0.006-inch thick have been consistently fed, but it is preferable to have a minimum thickness up around 1/32 or 1/16-inch for consistent separation of two washers which might come up together. On the high end of the range the limitation is more one of the maximum practical size of the feeder. Bowls 48 inches in diameter have been used, and larger ones will probably be used. The power requirements, the weight of the vibrator base required to absorb the forces involved, and the physical space occupied will set the practical limit.

Shape considerations which limit the practicability of vibratory feeding are largely concerned with tangling, meshing, and telescoping of parts. Conical and open end springs tangle to such a degree and with such ease that they are not considered good applications at this time. Straight springs with closed ends are being fed, and experience shows that the vibratory action tends to untangle some of the springs which were already tangled. The result is that most of the springs in a bowlful will feed out, leaving only a small percentage of tangled ones in the bowl.

There is a point in the loading of the bowl where the feeding action will slow down or stop. When a stored inventory of parts greater than that maximum bowl load is required, vibratory feeders must be equipped with auxiliary storage hoppers. These require sensing devices to indicate the level of parts in the bowl and control the auxiliary feeding action. They may be located over the bowl and allow the

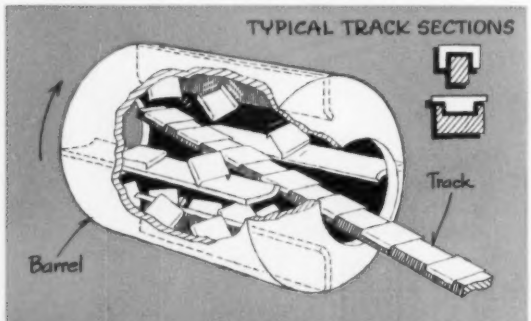


Fig. 6—Rotating barrel feeders use a rotating barrel to hold parts and drop them on a contoured track. This is one of the larger types of parts selectors and can handle a wide variety of part sizes. It is suitable for many stampings, light forgings, and other irregular shapes.

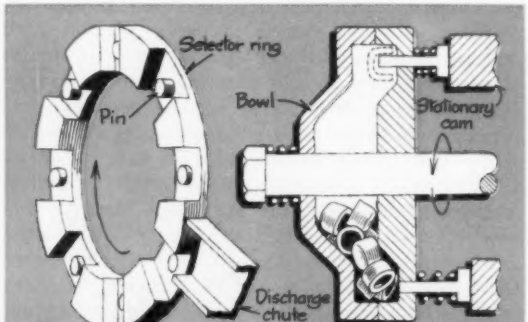


Fig. 7—Pin type parts selectors rotate a selector ring about a horizontal axis and past a mass of parts. Certain of the parts fall into slots in the ring and are carried upward. A pin is cammed into each slot to help retain a properly oriented part and eject an improperly oriented part back to the bowl. The pin then retracts to allow the part to move into the discharge chute.

parts to fall by gravity, or they may be floor mounted and use elevating conveyors.

Rate of parts delivery required will determine the size and number of vibratory parts feeders needed for a given job. As a general rule these feeders will operate at a delivery speed of 4 to 40 feet per minute, depending upon factors such as those already discussed. Once the maximum delivery rate for a given part and feeder is determined, it is necessary to add parallel feeder units to increase the delivery.

As with all other parts selectors, it is necessary that the parts supplied to the feeder be of suitable quality. For example, excessive oil can cause parts to stick together to such an extent that they jam the feeder; dirt, chips, and large scrap can also cause unsatisfactory feeding action.

▶ Other Parts Selectors

Oscillating box parts selectors, *Fig.* 4, include a box into which parts are loaded. This box is oscillated about a pivot at one end so that parts drop into slots or tracks in the box. When the box is in the proper position, a cam operated escapement releases the oriented parts to stationary magazines. These units are commercially available to feed screws, nails, rivets, balls, etc. As many as 18 tracks have been fed from a single box. Use of dividers in the box also makes it possible to simultaneously feed different types of parts from a single box.

Oscillating or reciprocating blade selectors, *Fig.* 5, pass a selecting blade through a mass of parts. The blade includes a profile which holds parts that fall on it in proper orientation. As the blade reaches the top of its stroke the parts slide down the blade, through a selective discharge gate, and into the delivery tube or track. Oscillating blade selectors are most commonly used for feeding cylinders and tubes having a length greater than their diameter. They are also adaptable for balls, slugs, and some irregular forms. Greatest advantages of this type of feeder are simplicity of design and a substantial rate of output.

Rotating barrel parts selectors, *Fig.* 6, depend on the tendency of a part to fall in a given manner a large percentage of the time. Parts are loaded into the barrel, and when the barrel is rotated, paddles or blades on the inner surface of the barrel lift up the parts and drop them as the barrel turns. Some of the parts will drop in the proper position on a track down which they can slide to the point of use. The rotation of the barrel also agitates the parts and continually re-orients them. This is one of the larger types of parts selectors and will handle a wide variation in part sizes. It is suitable for many irregular shapes, stampings, light forgings, etc.

Pin selectors, *Fig.* 7, are essentially rotating ring selectors. The selector ring rotates about a horizontal axis, and each slot in the ring has a pin which is moved in and out of the slot by a cam as the ring rotates. The pin is out of the slot when the slot is at the bottom of its travel; parts from the supply mass can thus fall into the slot. As the ring rotates, the pin is cammed into the slot so that properly oriented parts are retained in the slot while others are permitted to drop back to the mass in the bowl. As the ring continues to rotate, the pin is retracted out of the slot and the part is discharged to a chute. Pin selectors are used for cup-shaped parts, shouldered parts, rings, stampings, and parts with irregular shapes.

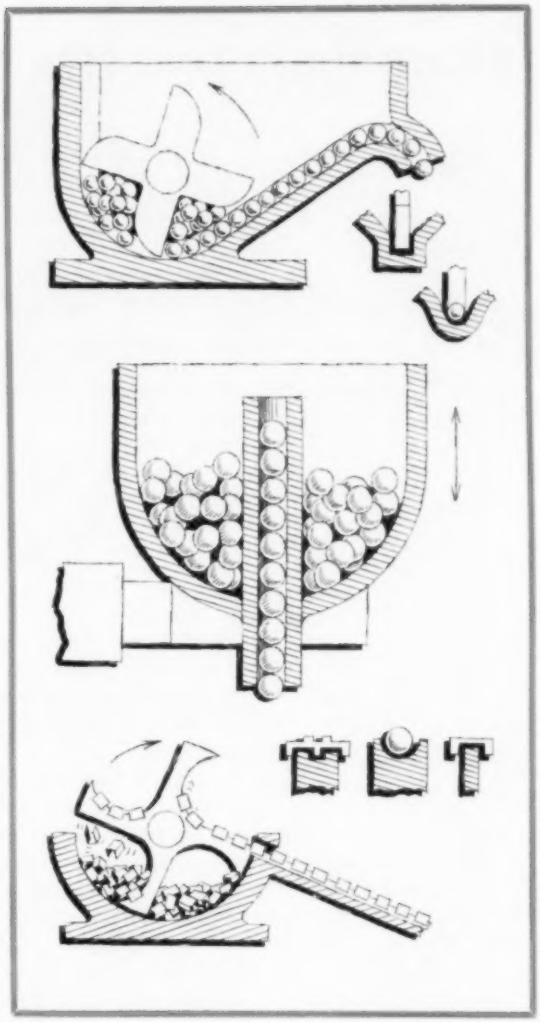


Fig. 8—Special part selector configurations are limited only by the ingenuity of the designer. The three special designs sketched here operate on the general principles of oscillating and reciprocating blade units.

Special types of parts selectors can be designed with an infinite number of variations, limited only by the ingenuity of the designer. Because of the added expenses in engineering, building, and repairing special units, they should be used only where necessary and where the job will justify the additional expense. Three types of special selectors are shown in *Fig.* 8. None of these are known to be available as standard units although all of them are used for specific applications. These three operate essentially on the same principles as oscillating or reciprocating blade parts selectors.

RIGHT-ANGLE TRANSFER DEVICE

LINKS WOODWORKING MACHINES

PRODUCTION of various products in the woodworking industry is greatly speeded through use of double-end machines which can perform simultaneous operations on opposite sides or ends of workpieces. In a number of instances it is expedient, production-wise, to arrange two such machines in an L-shape so that the path of motion of material leaving the first machine and entering the second machine forms a right angle. In the manufacture of flush doors, for example, the first machine can be set up for sizing to width and rounding or easing of corners, while the second machine can trim to length. The right-angle arrangement of machines obviates the need for turning the doors between operations.

Setups of this type sometimes employ an operator who receives material feeding out of the first machine and directs it at right angles toward the second machine. Use of a transfer device at the point of change of direction, however, can provide greater output per man through more automatic operation of the production line. A door-finishing line that employs a transfer device between double-end machines is shown in *Fig.* 1. Installed in a plant of Walled Lake Door Co., the line uses Greenlee Bros. & Co. woodworking machines.

Doors feed out of the first machine and are conveyed by powered, rubber-covered rollers into the transfer mechanism where they are stacked one on top of the other. As the third door reaches a position about halfway into the transfer mechanism, it trips a limit switch which starts the feed chains of the second machine. Dogs on the feed chains then automatically engage and carry the bottom door into the second machine.

Should the number of doors in the stack become less than two, another limit switch will operate to stop the feed of the second machine. If the first machine should overfeed to the extent that more than three doors accumulate in the transfer mechanism, a third limit switch will stop the feed of the first machine. In normal operation, however, stoppages due to under or overstacking are rarely experienced.

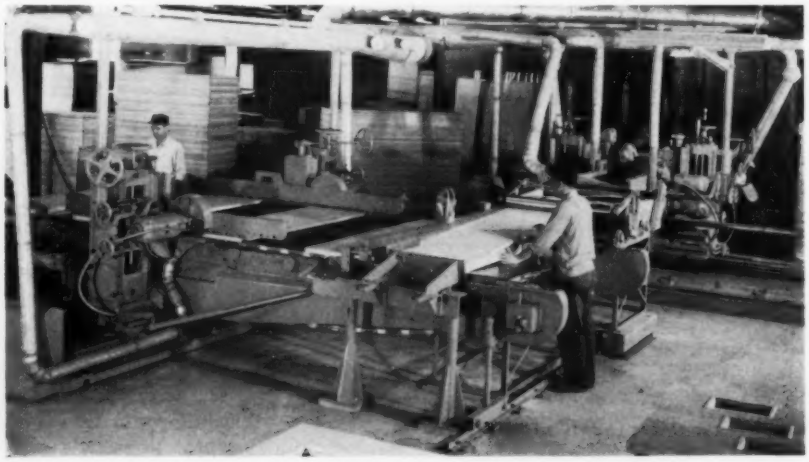


Fig. 1 — Continuous production setup for finishing flush doors to width and length. Machine in background trims doors to width and discharges them onto conveyor that carries them to transfer mechanism in right foreground. Transfer mechanism actuates feed chains of machine at left which trims doors to length.

SHEET HANDLING DEVICES IMPROVE PRESS OPERATIONS

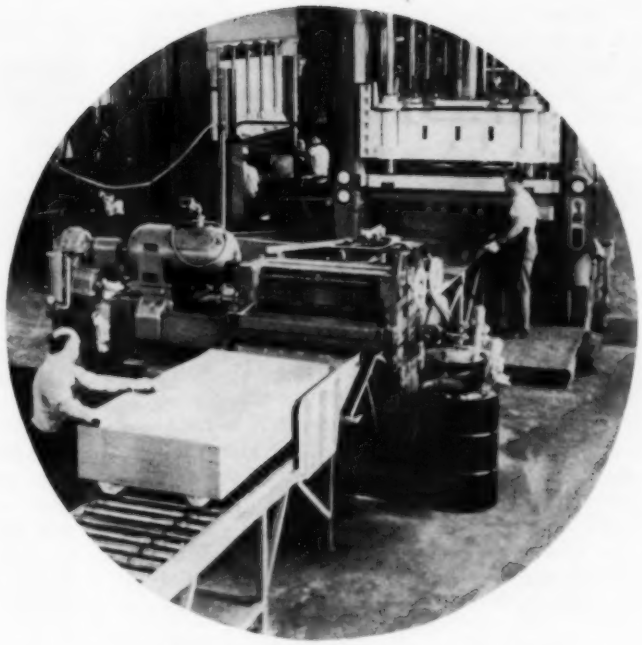


Fig. 1—View of press line at Whirlpool Corp. plant before installation of automatic sheet feeder and press loading devices

ELIMINATING the erratic, arduous, and dangerous manual handling of sheet steel at the beginning and between units of a press line is a significant improvement in metalworking operations. The prevalence of this type of problem involving sheet has led to the development of standard feeding and handling equipment which have widespread application in industry. However, where the problem warrants, special equipment can be developed—as is illustrated by an installation at a Whirlpool Corp. plant where clothes dryers are manufactured.

This installation, *Fig.* 1, was described in detail in an earlier issue of AUTOMATION.* At that time, plans to improve certain portions of the line involving materials handling were reported. Those plans have been translated into working realities and can now be described in some detail, *Fig.* 2.

To A Press

Engineers of the Whirlpool Corp.'s manufacturing research and development department worked with the Dexter Folder Co. in the development of a unique sheet feeder to handle sheet up to 1/8-inch thick, approximately four times the thickness of sheet typically handled by feeders.

In operation, an overhead crane delivers stock, banded onto skids, to a roller-conveyor which services the feeder. Steel strapping is removed and when the preceding stack has been depleted the new load is rolled forward beneath the feeding mechanism.

Vacuum-operated arms equipped with suction cups descend vertically to the top sheet and lift it as high as 18 inches to a series of magnetic rollers which suspend it in standby position until a pusher at the rear of the feeder advances and pushes the forward edge of the sheet between drive rollers. The drive rollers deliver the sheet to a ribbon conveyor having ribbed rubber carrier belts. As the trailing edge of the sheet moves onto the conveyor, a switch is tripped, causing the suction arms to descend and lift the next sheet to standby position. Sheets feed at the rate of four a minute, limited by the timing of the press cycle.

To aid in sheet separation, a pair of permanent magnets are mounted on the feeder frame at a rear corner of the stack. The magnets magnetize the upper sheets, areas of given polarity opposing like polarities at corresponding areas of adjacent sheets. Since like poles repel, the opposing magnetic fields tend to cause the top sheet to separate from the stack. The magnets can be adjusted by a crank to suit stack heights.

The feeder delivers the sheets to a roller-leveler unit which straightens burred edges and minor surface imperfections and passes the sheet under four spray nozzles which apply drawing compound to the top surface.

After the roller-leveler operation the sheet continues along a roller conveyor, tripping a switch which causes a feeding finger of a press loader to grasp the sheet and position it on the die of the first press—a 350-ton rough pierce and form HPM press. Simultaneously, another finger, at the opposite side of the press, removes the preceding blank. The only remaining manual operation in the entire line occurs at this point, when the operator removes

*H. R. Neighbours, "Automation Aids Steel Cabinet Forming," AUTOMATION, Vol. 4, No. 6, June 1957, pp. 94-96.

a circular slug from the die, using a permanent magnet at the end of a short wand. The die is being redesigned to eliminate this operation. The improved tool will permit the slug to fall through the die into a scrap bin under the press bed.

Between Presses

The unloading finger deposits the shroud blank onto a roller conveyor where it is picked up by a right-angle indexing conveyor. The indexing conveyor delivers the sheet onto the support rails of an automatic loader which services a Verson 400-ton piercing and trimming press. These rails also support an advance sheet, previously positioned for delivery into the press. The support rails raise and lower in transferring sheets, and work in conjunction with a carriage which is mounted on a second pair of elevator rails, these rails being located between the support rails.

In advancing a sheet, the carriage elevator rails rise, elevating the carriage from beneath the sheet. The carriage lifts the sheet off the support rails and moves forward.

In addition to moving the new sheet forward, the carriage is equipped with a feeder finger, and as carriage and finger move forward, the finger grasps the previously positioned sheet and places it in the press. The support rails lower as the carriage advances to bring the advancing finger in line with the previously positioned sheet.

As the sheet is placed in the press, the support rails rise and lift the new sheet off the carriage in position for feeding. At the same time the carriage rails lower. While this has been taking place, another sheet has been placed on the support rails at the other end and the carriage returns to pick it up and repeat the cycle.

Previously, four men were required to operate the portion of the line described: one fed the leveling rolls, one fed the HPM press, and two unloaded this press and loaded the Verson press. Continual improvements in efficiency and output are a common goal to all manufacturers—this installation serves as a reminder that improvements can be obtained and, with proper planning, integrated into operating facilities.

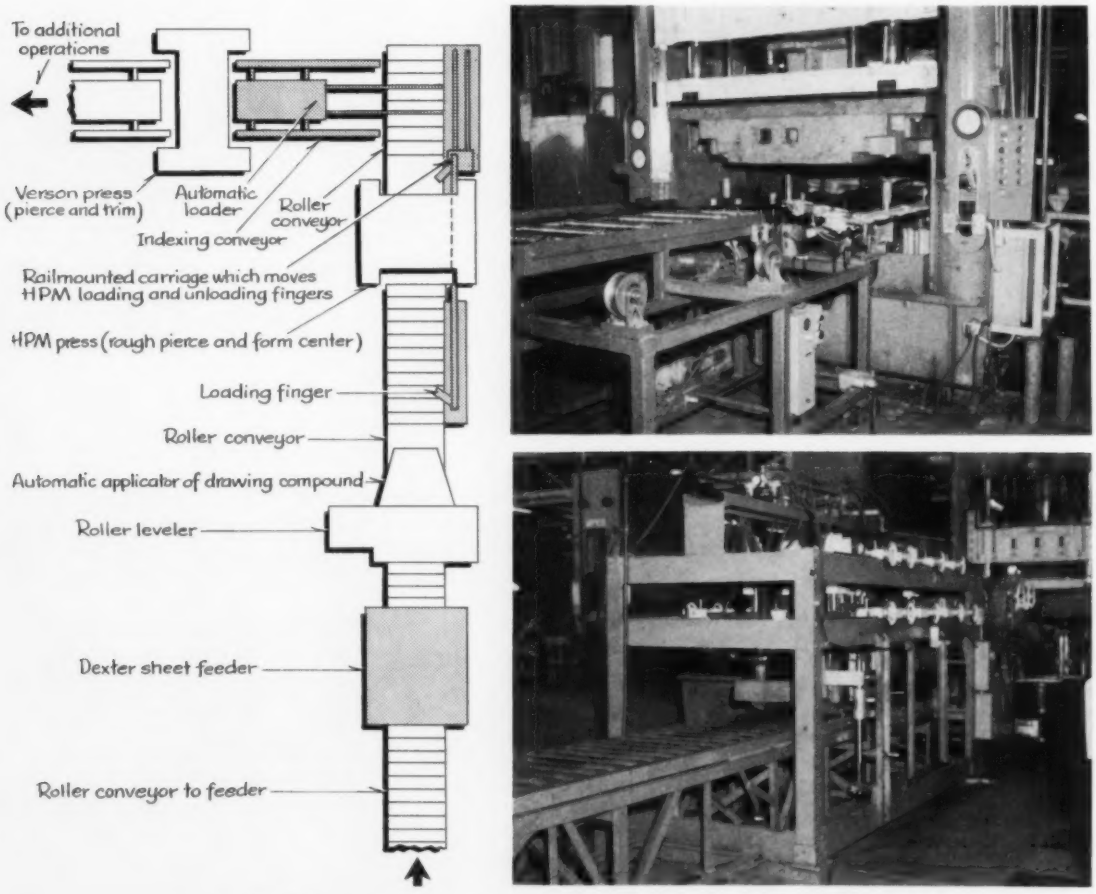
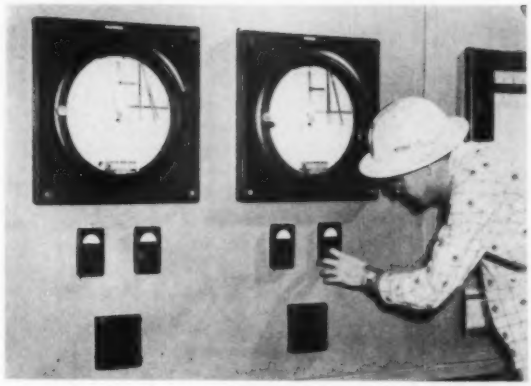


Fig. 2—Plan of portion of press line indicates location of automatic work handling devices. Lower picture shows Dexter sheet feeder; part of HPM press loading mechanism is shown in top photograph



ELECTROPNEUMATIC CONTROL SYSTEM UTILIZES COMMUNICATION CIRCUITS

STANDARD telephone cables are used by Stauffer Chemical Co. to transmit control signals over a 2½-mile distance separating a control panel and the point of control. The company adopted this method of signal transmission when faced with the problem of controlling and metering a split gas line supplying hydrogen chloride gas to two industrial users.

Practical considerations dictated the locating of metering equipment as close to the point of delivery as possible—in this case, the point at which the main pipeline splits into two customer delivery lines.

Individual measurements of flow, temperature, and pressure on each delivery pipeline are transmitted by the telephone cable. This cable also handles many pairs of telephone communication lines without interference to the control signals. At the plant control panel, the signals are converted from electronic to pneumatic form for operation of a standard three-pen recorder.

In addition, the electronic signal for flow is fed to an indicating set station where it is compared with a desired set point value. Deviations between the actual and desired value produce a control signal that feeds back through the telephone cable to a transducer at the field metering station. Conversion of this feedback signal to pneumatic form actuates a pneumatic flow control valve to obtain the set point value. The valves are actuated by air supplied by three small compressors located at the site. Remote manual operation of the flow control valves over the same circuits can be accomplished.

The considered opinion of experts is that both electronic and pneumatic devices have a logical role to perform in process industries. This installation illustrates how such devices are combined to obtain a practical solution to the problem of control over a relatively great distance.

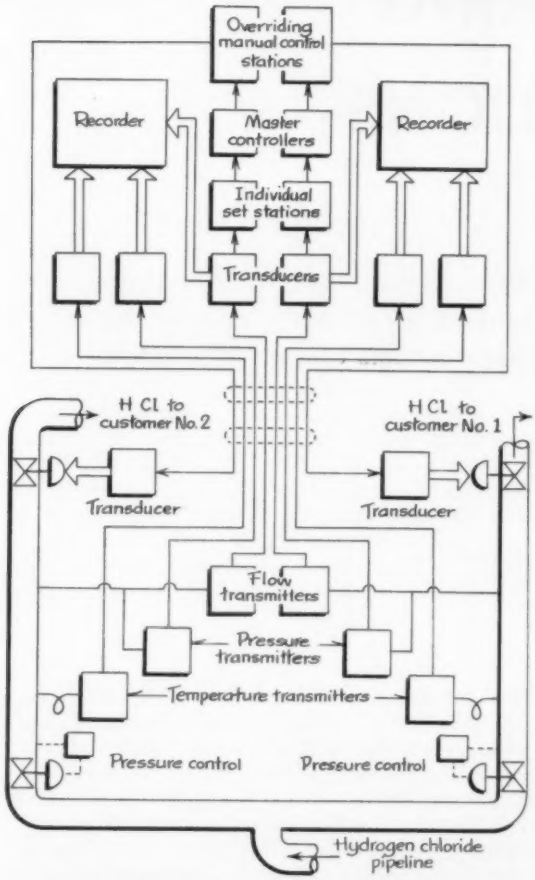
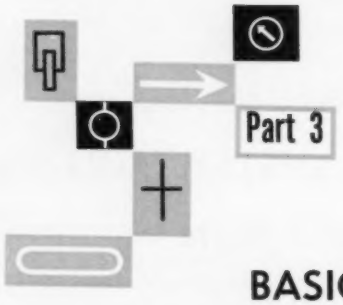


Fig. 1—Signals for remote metering and control of pipelines carrying hydrogen chloride gas are transmitted over standard telephone cable. The control point is located 2½ miles from the metering point. As indicated, control system consists of pneumatic devices linked together by electronic means to achieve automatic control.



BASIC PNEUMATICS FOR AUTOMATION

INTERLOCKING TWO MOTIONS

Sequencing of motions of different machine elements is often required. Simultaneous motions at related rates are frequently needed too. Pneumatic circuits can provide such interlocked motions.

By **H. L. STEWART and J. M. MORITZ,** Logansport, Ind.

PRECEDING ARTICLES of this series provided pneumatic circuits showing the use of one pneumatic cylinder in simple circuits to provide movement in one or two directions. This article goes a step further to show how simple circuits can be combined to sequence or synchronize actions of two or more cylinders. Such timing may require that motions occur in a predetermined sequence or occur simultaneously at related rates. Components for pneumatic circuits to provide such regulated motions include sequence valves, four-way valves, and air-oil cylinders.

▶ Sequencing With Four-Way Valves

The circuit in *Fig.* 15 makes use of a pilot operated system to effect a positive sequence. There is no chance for the second piston to start moving until the first reaches the end of its travel. In this application, workpiece *A* is moved to location *X*, cam roller on pilot valve *B* is depressed, directing air to pilot chamber *S* of valve *C*, shifting spool of this valve. Air pressure is directed to blind end of infeed cylinder *D*. Piston of cylinder moves forward at speed controlled by flow control *E*, and workpiece is moved to and held at point *Y*. Work is performed upon the workpiece with a mechanical motion, and as this is completed, roller of cam valve *F* is momentarily depressed, directing air to pilot chamber *T* of valve *C*. Spool of *C* shifts to original position, air is directed to rod end of infeed cylinder *D*, and piston is retracted. As the slide fastened to piston rod of cylinder *D* nears the retracted position, a swing type cam trips roller of pilot valve *G*. Air pressure is directed to pilot chamber *V* of valve *H*, shifting its spool and directing air to blind end of ejector cylinder *J*. Piston of ejection cylinder moves workpiece *A* to point *Z* at a speed controlled by flow control *K*. At end of ejection stroke, ejecting mechanism contacts cam roller of pilot valve *L*, and air pressure is directed to pilot chamber *W* of valve *H*. Air pressure is then directed to rod end of ejector cylinder, retracting piston. When it is in the retracted position, the ejector slide contacts roller of pilot valve *M*. This valve is placed in the cir-

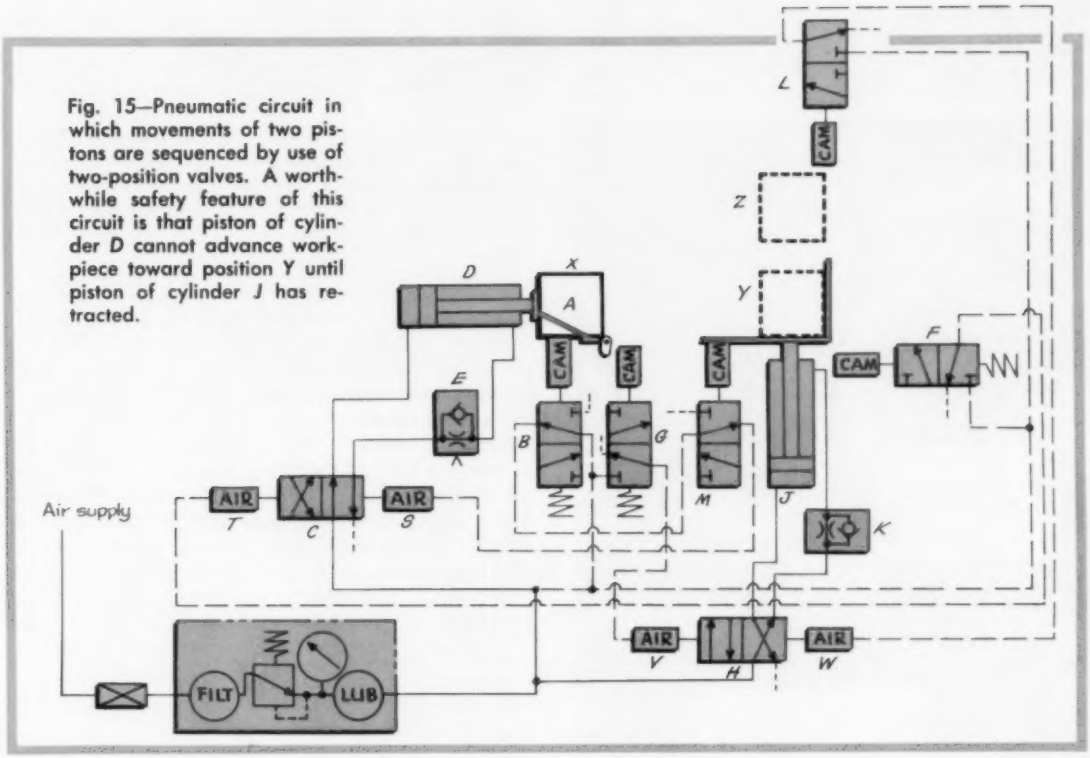


Fig. 15—Pneumatic circuit in which movements of two pistons are sequenced by use of two-position valves. A worthwhile safety feature of this circuit is that piston of cylinder *D* cannot advance workpiece toward position *Y* until piston of cylinder *J* has retracted.

cuit as a safety measure so that when cylinder *D* is retracted and there is a workpiece at point *X*, the piston of cylinder *D* cannot move forward until the piston of cylinder *J* is fully retracted. This control is a feature that should be added where there is any possibility of a cylinder causing a movement before another cylinder is in a desired condition.

▶ Using Sequence Valves

The sequence valve, *Fig.* 16, can be classed as a pressure control. The particular unit shown also includes an integral check valve for free reverse flow. It opens and closes as pressure increases or decreases. The pressure at which the valve opens is controlled by the force exerted by a control spring. This force can be increased or decreased by changing the setting of an adjusting screw. The force which causes this valve to open is obtained from the air pressure entering the inlet port and working on the exposed area of the seat assembly. As soon as the seat assembly starts to rise the full seat is exposed to air pressure, keeping it raised, and air flows out the outlet port.

The designer should realize the advantages and disadvantages of using sequence valves to effect a sequence of operations. Here are some of the advantages:

1. Elimination of additional four-way control valves for sequencing purposes. This reduces the over-all cost of the system even if two sequence valves are used, and it also eliminates the need to provide actuators for the second control valve. Sometimes it is difficult to provide a means of actuation for a second valve.

2. Reduction in piping. In most instances the use of sequence valves requires less piping than that required when using additional four-way valves for sequencing.

3. Sequence valves are hung in the pipe lines, which eliminates the need to provide mounting means.

4. Sequence valves without integral check valves can be

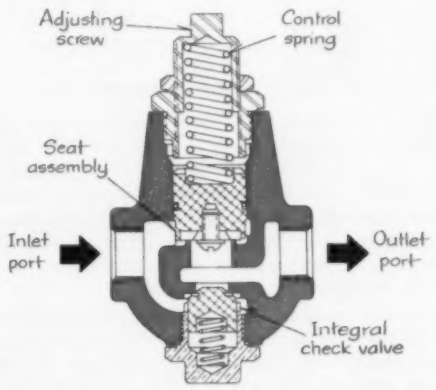


Fig. 16—Sequence valve, shown in cross-sectional view, is a type of pressure control. When pressure at the inlet port reaches a preset limit, the valve allows air to flow to the outlet port. Sequence valves can be used to direct air to a second cylinder only after pressure in a first cylinder has reached a preset level. Unit shown includes an integral check valve for free reverse flow.

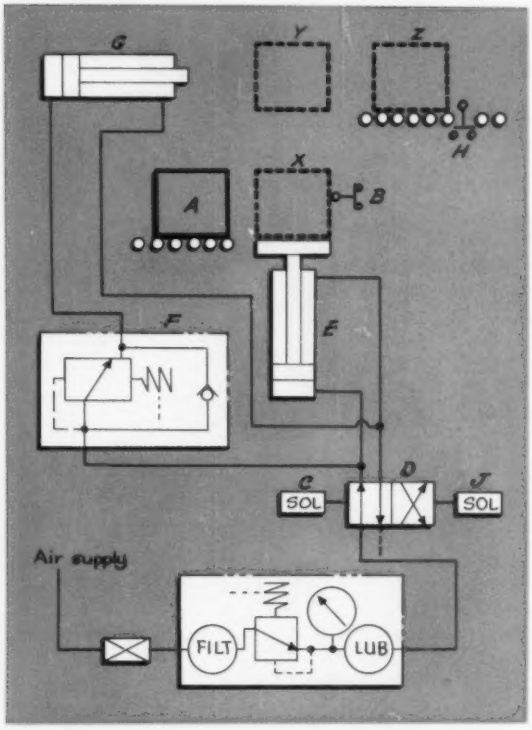


Fig. 17—Use of a sequence valve in this circuit allows one four-way valve to control sequenced advance and retraction of two pistons. Piston of cylinder G does not advance until pressure in cylinder *E* is sufficient to open the sequence valve. In this circuit both pistons retract at the same time.

used to advantage as holding devices when placed backwards in the circuit since they are designed with a seat that gives a positive seal as long as dirt does not break the seal.

Some of the disadvantages of sequence valves are:

1. They are troublesome if there is drastic fluctuation in line pressure. The designer should check to see if the line pressure in the plant is rather steady or if it varies greatly. If the pressure should drop below the setting of the sequence valve, the valve will not open. If the line pressure fluctuates above and below the valve setting, the operation of the component which the valve controls will be very erratic. It may operate on one cycle and not on the next.

2. Valve may open at wrong moment. Although in many circuits this presents no problem, the designer should take this fact into consideration. Suppose that a cylinder that moves a carriage must get the carriage out of the way of a tool before the tool is advanced by a cylinder released by a sequence valve. If the carriage cylinder should be jammed by a falling object, or by some other cause, the pressure buildup will open the sequence valve. This will allow the tool cylinder to ram the tool into the carriage and may cause considerable damage. If sequence valves are used, the designer must make certain that there is no possibility of this occurrence.

3. If the lines in the pneumatic system are exceptionally dirty, sequence valves may cause trouble. Dirt can lodge in the seats of these valves, causing leakage, allowing air to seep to the second component, and causing it to move prematurely.

4. If pressure required to make the first movement is greater than that required to make the second movement, and due to space requirements it is necessary to use cylinders of the same bore for both movements, sequence valves are not satisfactory. This situation may be somewhat remote, but it can arise.

In the application shown in *Fig.* 17, object *A* is moved onto an elevator from an infeed mechanism. As it is, limit switch *B* is momentarily tripped, energizing solenoid coil *C* of valve *D*, shifting spool in valve, and directing air pressure to blind end of elevating cylinder *E*. Piston of cylinder *E* moves up, raising elevator to its top position. Then air pressure builds up, opening sequence valve *F*, and air is directed to blind end of ejector cylinder *G*. Air pressure moves piston of this cylinder forward, ejecting workpiece *A* onto transfer mechanism. As workpiece moves away on transfer mechanism, limit switch *H* is momentarily contacted, energizing coil *J* of valve *D*, which causes valve spool to shift. Air is directed to the rod ends of cylinders *E* and *G*,

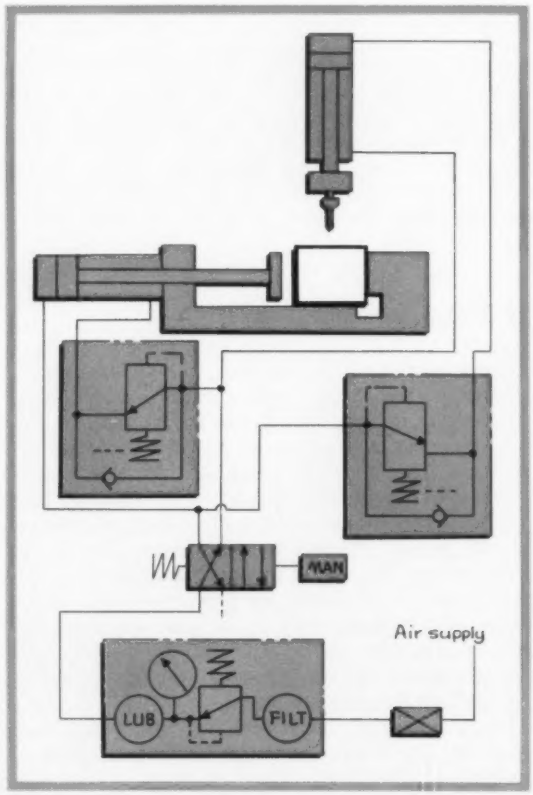


Fig. 18—Two sequence valves are used in this circuit so that a drill will not enter the work until the work is clamped, and the clamp will not be released until the drill is retracted from the work.

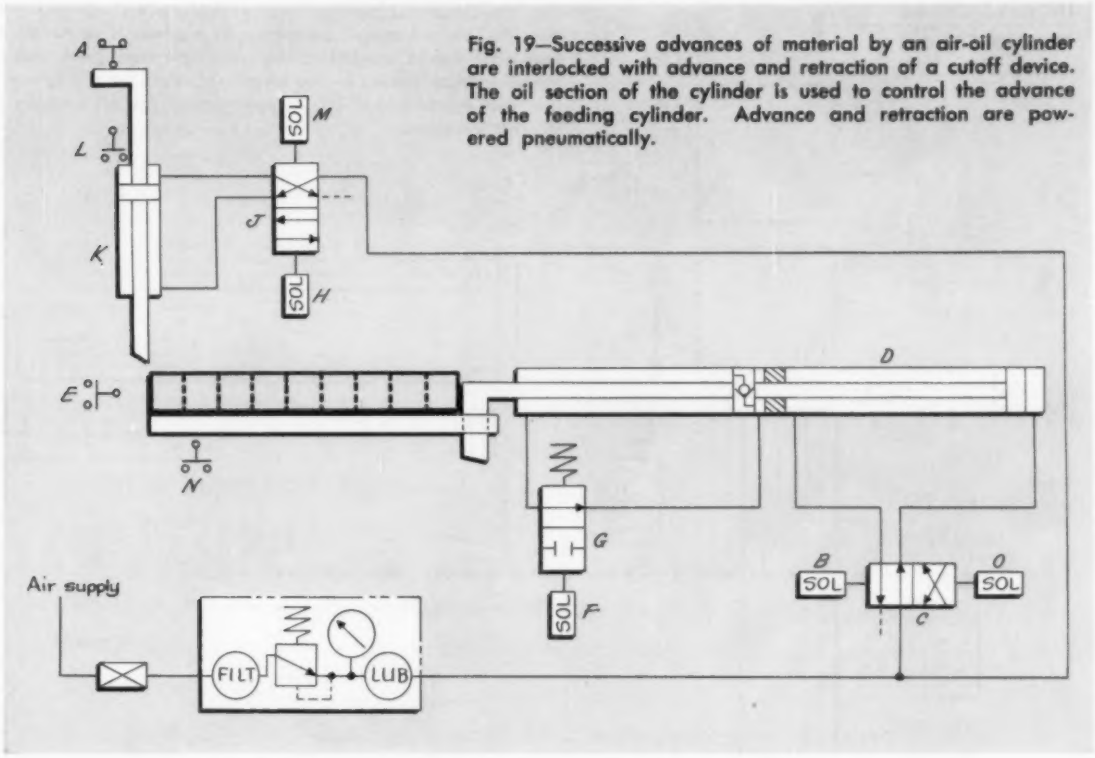


Fig. 19—Successive advances of material by an air-oil cylinder are interlocked with advance and retraction of a cutoff device. The oil section of the cylinder is used to control the advance of the feeding cylinder. Advance and retraction are powered pneumatically.

and pistons of both cylinders retract, completing cycle.

Fig. 18 goes a step further and makes use of two sequence valves to provide a sequence in both advance and retraction of two pistons. Often it is necessary to have a sequence in the second half of the cycle instead of having the pistons of both cylinders return at will. For example, if the first movement provides clamping and the second movement pushes a burnishing tool, reamer, drill, or gage into the workpiece, it is desirable to clamp that workpiece solidly until after the tool is removed from the work. Hence the use of the second sequence valve.

▶ Interlocked Stepping

A stepping application can be worked out very conveniently using an air-oil cylinder and two-position valves. This reduces the electrical equipment required, and provides a smooth, even movement of the stepping cylinder since the movement is controlled by oil. In *Fig.* 19, limit switch *A* is momentarily tripped, directs current to coil *B* of solenoid valve *C*, shifting spool and directing air to blind end of stepping cylinder *D*. Piston starts to move forward. It progresses until limit switch *E* energizes coil *F* of normally-open two-way valve *G*, shutting off oil flow and stopping piston of cylinder. At the same instant, coil *H* of four-way two-position valve *J* is energized, shifting the valve spool and directing air to blind end of cutoff cylinder *K*. Cutoff device advances and performs the operation. At end of cutoff piston stroke, limit switch *L* is contacted, energizing coil *M* of valve *J*, and spool is shifted, directing air pressure to rod end of cutoff cylinder. Piston retracts to normal position. Solenoid *F* of valve *G* is de-energized, releasing spool to original position, and oil from cylinder *D* is again free to flow through it. Piston of cylinder *D* again advances.

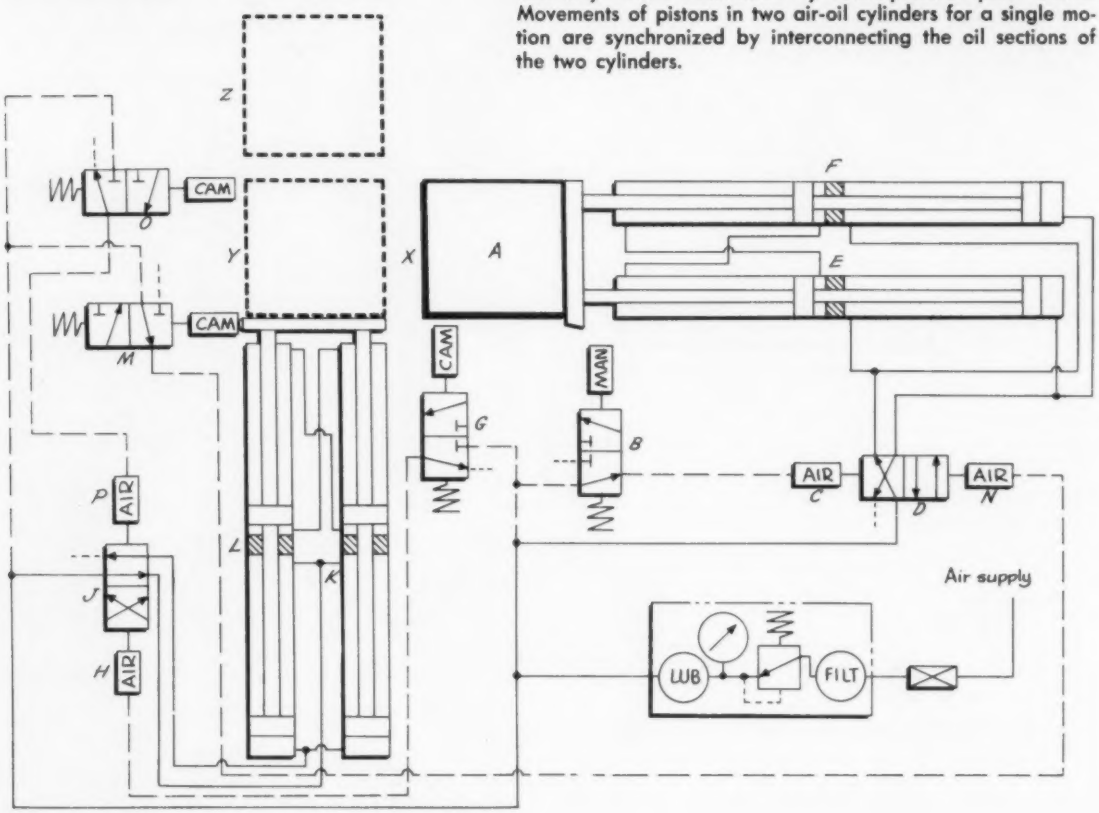
This sequence continues until the piston of cylinder *D* reaches the extent of its stroke and piston of cutoff cylinder is in retracted position. At that time limit switch *N* energizes coil *O* of valve *C*. Spool of valve *C* is shifted to original position, and air flows to center section of air-oil cylinder *D*. The piston is retracted at a rapid rate as oil moves through check valves in oil piston. When piston is fully retracted, the next bar can be moved into position.

▶ Synchronizing Two Motions

There are applications where it is desirable to synchronize two motions. Mechanically it is not too difficult; hydraulically it presents a number of problems; and pneumatically it is not practical. However, a combination of pneumatics and hydraulics makes this problem quite a simple one. How to solve this problem is shown in *Fig.* 20. Here, manual trip on pilot valve *B* is momentarily depressed, re-

INTERLOCKING TWO MOTIONS

Fig. 20—Circuit for moving large workpiece requires two cylinders for each motion. Sequence of motions is provided by four-way valves controlled by cam-operated pilot valves. Movements of pistons in two air-oil cylinders for a single motion are synchronized by interconnecting the oil sections of the two cylinders.



leasing air pressure from chamber *C* of four-way valve *D*, shifting valve spool, and directing air to the blind ends of cylinders *E* and *F*. Since the workpiece which is being moved is quite large, it is necessary that two cylinders be used, and the pistons of these cylinders must be synchronized. This synchronization is accomplished by using air-oil cylinders and crossing the oil lines. When the cylinders reach the ends of the stroke, cam roller of valve *G* is tripped, putting pressure on pilot *H* and shifting spool in valve *J* to direct air to blind ends of cylinders *K* and *L*. Their pistons move forward in synchronization, transferring the workpiece. When the roller of valve *M* is released by advance of these pistons, pressure is exhausted from pilot *N*, shifting spool of valve *D*, and directing air to rod ends of cylinders *E* and *F*. Pistons of cylinders *E* and *F* then retract. At the end of travel for pistons in cylinders *K* and *L*, roller of valve *O* is depressed, shifting spool of valve *J*, putting pressure on pilot *P*, and directing air pressure to rod ends of cylinders *K* and *L*. The pistons retract to starting position, where valve *M* is tripped. System is then ready to cycle again. By inserting flow controls in the crossed oil lines, one can obtain different speeds in each direction of movement.

Circuits in this article show some of the more simple arrangements used in moving an object from point *X* to *Y*, then to *Z*. Fixed flow controls or cam-operated flow controls could be added to adjust feeds and speeds; they should be placed so air is metered as it leaves the cylinders.

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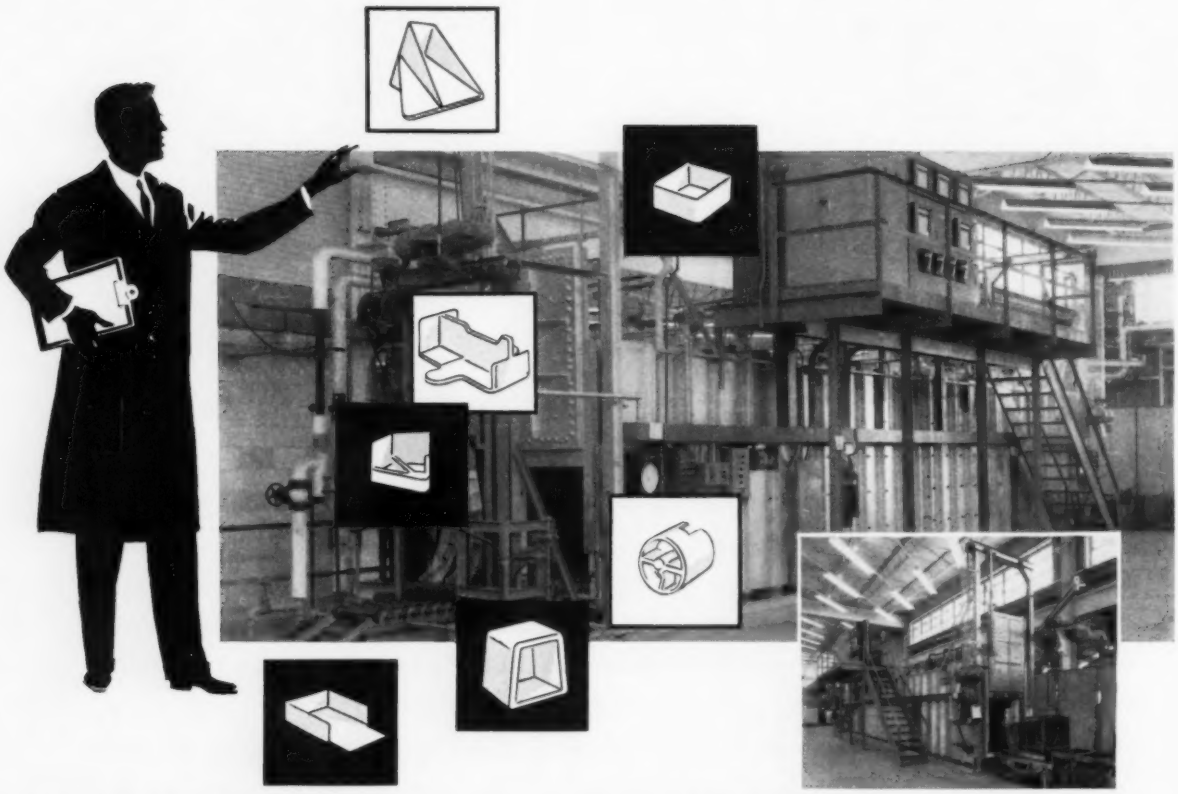
*AIR CIRCUITRY is the Westinghouse term for application of pneumatic control systems to industrial production operations.



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☐ Vacuum Heat Treating	☐ Atmosphere Equipment
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Circle 689 on Page 165

AUTOMATION

new equipment

Machines and plant equipment for more automatic operations

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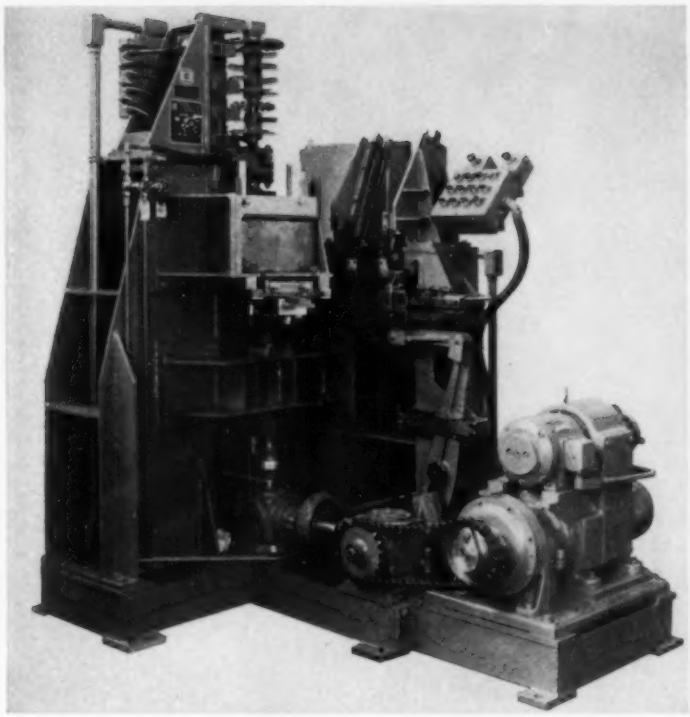
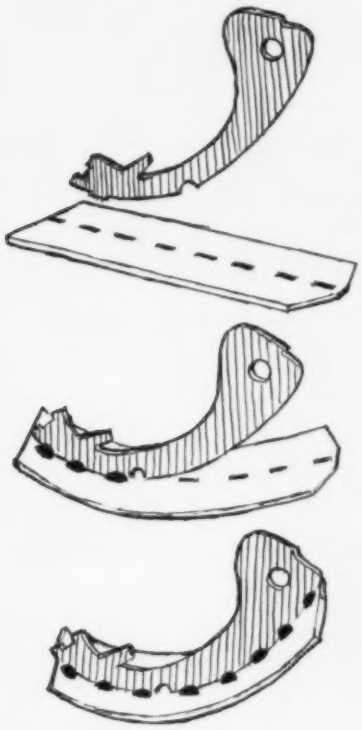




Automatic Brake Shoe Former and Welder

WELDING of brake shoe rims to webs, at a high production rate, is accomplished by loading the plates, or rims, in a flat condition and forming or curving them simultaneously with the welding operation. Designed by **National Electric Welding Machines Co.**, 1846 Trumbull St., Bay City, Mich., unit features simplicity of feeding and welding action, and easy accessibility of components for adjustment and changeover.

In operation, both parts of the brake shoe assemblies are stack loaded into hoppers from which the plates and webs are automatically shuttle-fed into a fixture by motor-driven crank arms and reciprocating pushers. Parts are fed from the bottoms of the stacks at the proper time. The pushers are equipped with friction-ball couplings that release automatically if a defective part becomes jammed during feeding. Parts are self-positioned by a slot and key. Plates are loaded in a flat condition and formed during welding. Each plate has eight welding projections in a straight row. The fixture rotates continuously during production, with the ram remaining under pressure except between shoes. When completed, the parts are automatically stripped from the fixture and slide down a chute.

The welding fixture of each unit is a driven, current-carrying assembly. It is mounted on a vertical shaft, supported by insulated tapered roller bearings, and has spring-loaded pressure pads for distributing clamping force over the web. Two work assemblies are handled in the fixture at the same time, 180 degrees from each other. While one is loaded, a second is being welded and disposed of. Welding pressure and completion of the circuit are provided by a horizontally sliding hydraulic ram with an antifriction seam welding shaft and roll assembly, connected by laminations to a 200 kva, single-phase welding transformer. Shuttle feeds and fixture are driven from a single

2 hp, 1200 rpm motor. Various functions are sequenced by the adjustable cams on the upper extension of the fixture shaft. Hydraulic pressure is furnished by a separate 3 hp motor-driven unit. Production rate is 1200 complete brake shoe assemblies per hour.

Circle 401 on Page 165

Electronic Computer

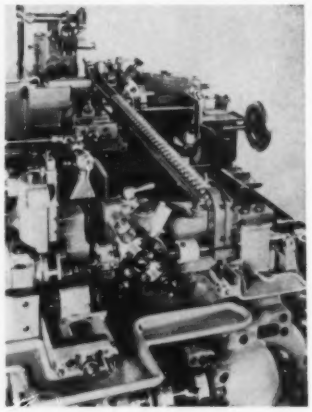
Item 402

Unit is capable of solving scientific problems, arithmetical calculations, and business problems such as payroll computations, production control, and marketing research. The Electronic Computing Machine (ECM) uses electronic means to perform all basic types of computations. Figures are entered into the system by an adding machine-type keyboard mounted in the top of the desk. The computations are performed by an electronic unit stored in the drawer section of the desk and results are printed automatically on an adding machine-type print unit. The unit adds or subtracts amounts from immediate or successive computations. It multiplies and divides, performing these operations repetitively or in combination as required.

Information can be keyed in from source documents and stored in the electronic unit until it has served its purpose in the computation. Multiple results can be computed and held in the unit until they are printed. Often-used programs can be preset into a program cartridge and plugged into the program panel in seconds. All programs can be visually checked and corrected. The system consists of four desk-mounted units connected by electrical cables: They are: A key entry unit, an electronic computation unit, a programming unit, and a printing unit.

The entry unit has a standard 10-key keyboard along with function and operation keys for manual operation. Factors keyed into the entry unit are transferred to the designated memory locations in the electronic computation unit's magnetic drum storage. Results of all operations performed are transferred back to the printing unit under print-out control. Negative results print in red and positive in black. The unit prints up to 18 digits and as many as three identifying symbols. A program unit supplies electronic impulses which control the predetermined sequence of steps during an operation. **Clary Corp.**, 408 Junipero St., San Gabriel, Calif.

Circle 402 on Page 165

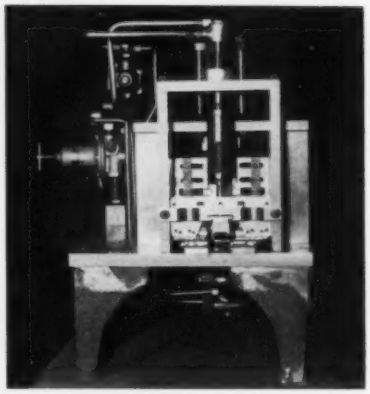


Linked Machine Tool

Item 403

Multiple machining operations on complicated parts are made possible by integrating two of company's turret automatics with an automatic transfer system. First operation work is performed on bar stock by a Model B 42 single spindle turret automatic. Cut-off parts are then transferred automatically by a transfer chute into the magazine of a Model 25 S turret automatic for second operation work. Operations include threading, eccentric turning, straight turning, and broaching a blind internal hexagon. The second operation machine automatically ejects the parts after they are completed. **Wickman Products Corp.**, 10325 Capital Ave., Oak Park 37, Mich.

Circle 403 on Page 165



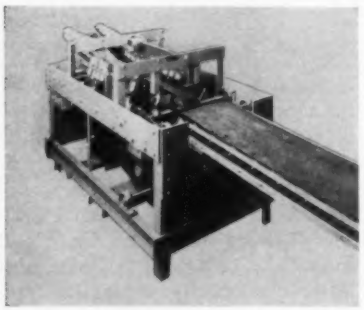
Lead Straightener

Item 404

Unit is capable of automatically cutting and straightening wire leads on any coaxial lead electronic components such as capacitors, resistors, diodes, and transistors. The hopper is designed for mechanical or manual feeding of components into the machine.

Leads are cut and straightened, and parts are discharged in position to be automatically fed to packaging equipment or to other manufacturing steps. Leads which are off-center are automatically centered while being straightened. Production rate is up to 3000 pieces per hour. **Hill Mfg. Co. Inc.**, Lydonville, Vt.

Circle 404 on Page 165

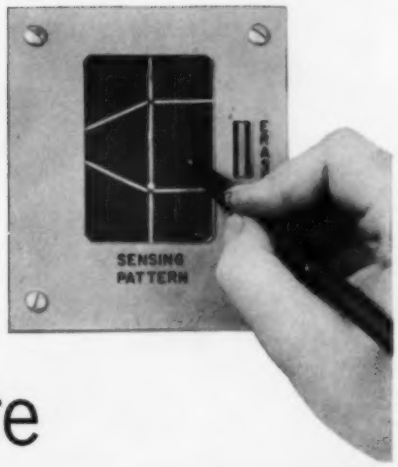


Ingot Printer

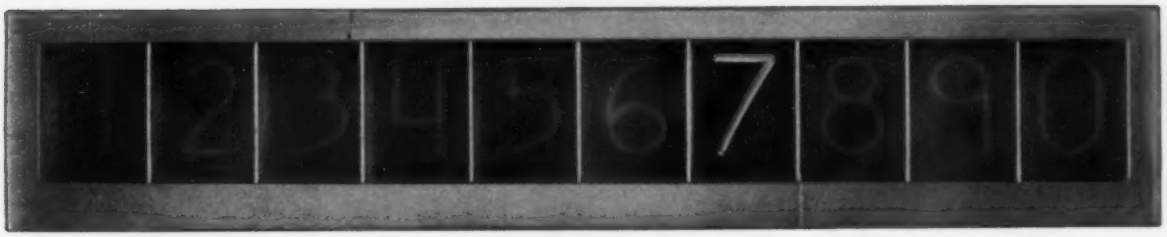
Item 405

Machine is capable of imprinting ingots on a production line operation, providing identification such as specific melts, individual analysis, and dates cast. Unit has an in-

Write a numeral here



and read it here



on new Bell Labs machine

A new device invented at Bell Laboratories "reads" a numeral while it is being written and instantly converts it into distinctive electric signals. The signals may be employed to make a numeral light up in a display panel, as above, or they may be sent to a computer or to a magnetic "memory" for storage.

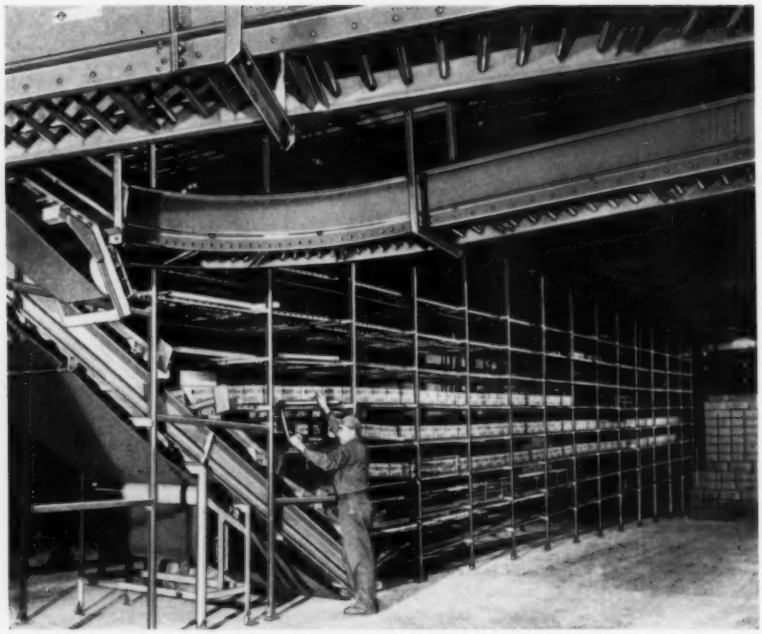
The writing is done with a metal stylus on a specially prepared surface. Two dots, one above the other, are used as reference points. Seven sensitized lines extend radially from the dots. Transistorized logic circuits recognize numerals according to which lines are crossed.

The concept of a number-reader has interesting possibilities as a new means of communication from humans to machines. For example, in an adjunct to a telephone, it might provide inexpensive means of converting handwritten data into signals which machines can read. The signals could be transmitted through the regular telephone network to a teletypewriter or computer at a distant point. In this way, a salesman might quickly and easily furnish sales data to headquarters, or a merchant might order goods from a warehouse.

Tom Dimond, a B.S. in E.E. from the University of Iowa, demonstrates an experimental model of his number-reading invention. A similar device can also be made to read alphabetical characters. Small size and low power requirements result from transistor circuitry.

Modern communication involves many more fields of inquiry than the transmission and reception of sound. The experimental number-reader is but one example of Bell Telephone Laboratories work to improve communications service.

BELL TELEPHONE LABORATORIES
World Center of Communications Research and Development



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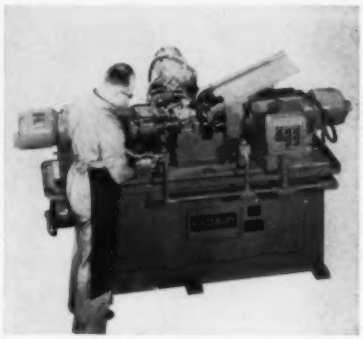
feed conveyor to carry ingots through the printing area. As each ingot passes through this area, it is automatically positioned by spring tension guides for full surface pressure against the printing head activator, which in turn inks the head and positions it against the ingot to make the necessary impression. Ink is taken from a self-contained fountain and transferred to the printing head by means of a series of self-cleaning rollers. After the ingot has been imprinted, it automatically moves onto another integral conveyor belt. **Industrial Marking Equipment Co. Inc.**, 454 Baltic St., Brooklyn, N. Y.

Circle 405 on Page 165



Automatic Drill

Item 406

Machine automatically drills four holes in transmission shafts at a rate of 310 parts per hour. In operation, the shafts are placed in a loading ramp. A work fixture in the center holds one part at a time. An air cylinder behind the fixture swings a carriage that takes the bottom part from the ramp and clamps it against locating pins. During the operating cycle, three units mounted in a T-shape advance and drill the four holes. The two opposed units are electrically timed to prevent tool clash. An air circuit trips all three units as soon as the part is clamped and then trips the clamping mechanism when the last operation is finished. When the operation is over, the finished piece drops into a chute in the rear of the machine and the air cylinder swings the carriage back to the ramp for a new piece. **Kingsbury Machine Tool Corp.**, Keene, N. H.

Circle 406 on Page 165

Parts Storage Unit

Item 407

Suitable for use in automated processing lines, unit features a zig-zag gravity part-retaining track which is fed from an integrated parts elevator. The feeding system is designed to provide a continuous stream of parts, even during tool changes. Two five-digit counters built into the control panel supply a running parts inventory. One counter tabulates "parts in," the other "parts out." Transparent sliding doors on both sides of the unit afford visual inspection.

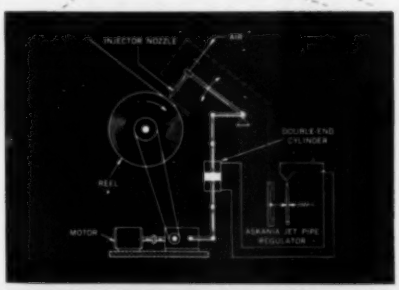
In operation, parts are fed from a distribution system to an entry at the lower right end of the unit where they enter a parts elevator and are raised to the top of the cabinet and roll into the first section of zig-zag tracks. Each part traverses five sections of track, rolling from top to bottom, is then re-elevated for entry into the second section. Parts leave the unit from an exit chute at the upper left end of the cabinet. The parts elevator is a roller chain type using only two chains connected by bars, driven by a ¼ hp motor through a speed reducer and a V-belt drive. Belt speed is variable to suit the application. As parts leave the retaining tracks at the upper level of the equipment, gravity rolls them to the exit chute take-off where parts can be positioned vertically or horizontally for the following machine operation. A limit switch in the exit chute automatically shuts off the equipment if parts back up from the subsequent operation. **Gear-O-Mation Div., Michigan Tool Co.,** 7173 E. McNichols Rd., Detroit 12, Mich.

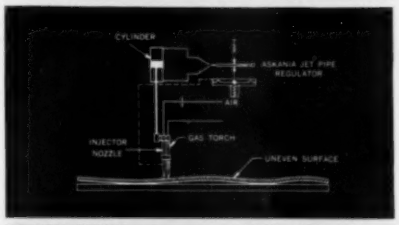
Circle 407 on Page 165

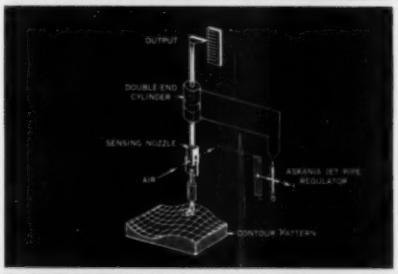
Circle 691 on Page 165→

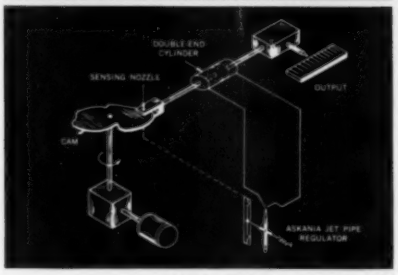
Powerful, accurate position control from

a breath of air!









Askania Jet Pipe Principle makes possible non-contact, high-output position servos

A breath of air that will just barely hold a feather aloft is all it takes for accurate sensing of a surface position in a system that incorporates the Askania Jet Pipe relay. High-level output from extremely low pressure signals is a built-in feature of Askania hydraulic controls.

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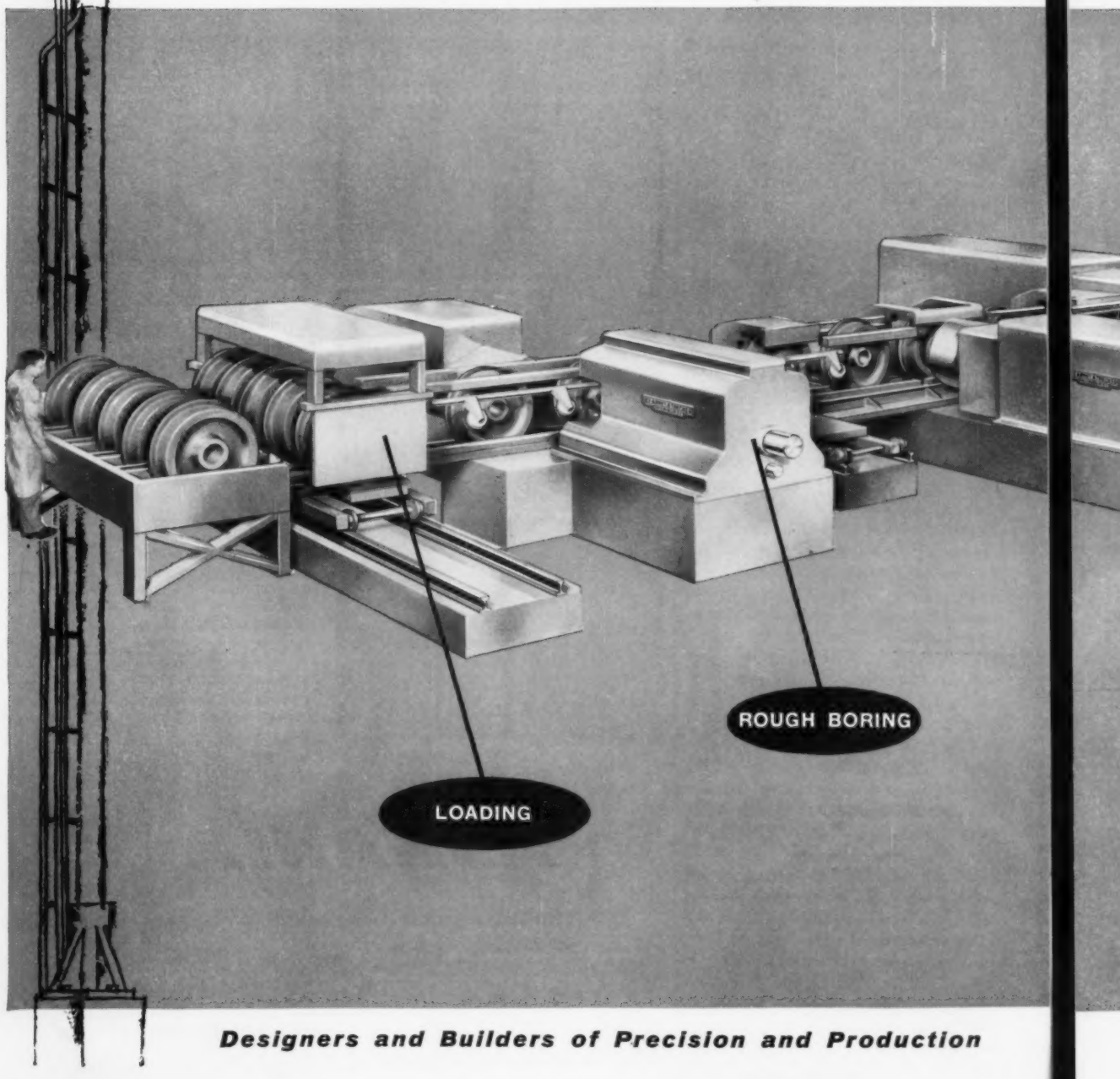

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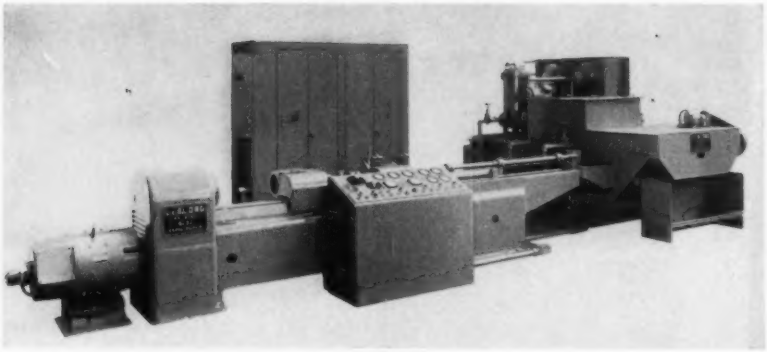
Circle 692 on Page 165



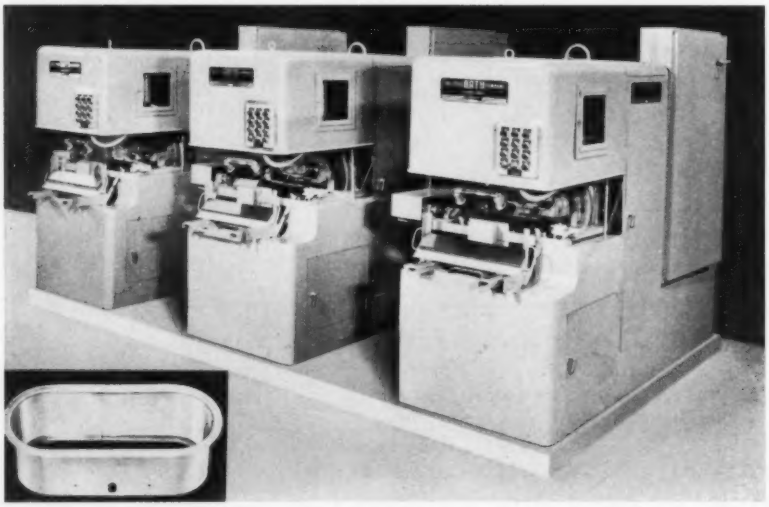
Boring, Trepanning, and Counterboring Machine

Item 408

Device is suitable for work that is symmetrical for balance in rotation, such as a round, square, octagonal, tapered, or stepped object. It will solid bore, trepan, or counterbore holes from 5/16 to 4¼ inches in diameter. Unit can also handle identical parts which can be bored as one piece, then cut apart.

In operation, cutting oil is forced between the boring bar and hole wall, forming a continuous bearing. It flushes back through a hole in the boring head and bar, carrying away the chips as it goes. Tool faces in the chip form are kept clean and chip passage clear by control of the tool angles and proper combination of feed and speed. The concentricity is controlled by the design of the cutter, which provides balanced cutting pressures. Borer is available in 3 sizes designated No. 15, No. 30, and No. 60. **R. K. LeBlond Machine Tool Co.**, 2684 Madison Rd., Cincinnati 8, Ohio.

Circle 408 on Page 165



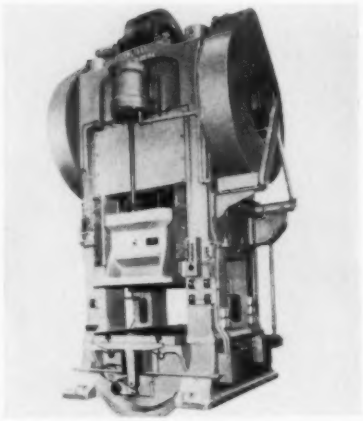
Metal Forming Machine

Item 409

Automatic unit produces automotive air inlet ducts at approximately 1500 pieces per hour. The progress of work through the machine is automatically timed and cycled. The three forming heads in the machine are independently powered for separate maintenance and adjustability. Stacked blanks are supplied to each head on interchangeable loading hoppers. The blanks are automatically separated and moved to a preload station where they are positioned prior to insertion in the forming dies. The blank is then transferred to the forming position while a previously formed part is being ejected.

The transfer of the blank into the forming die actuates two forming wings that tangent-wipe the flanged duct to shape. The forming wings then retract to their original *at rest* position and automatic ejectors unload the formed part into a gravity chute leading to a carry-away conveyor. When double or oversized blanks are accidentally loaded into the forming dies, the machine automatically stops. **Cyril Bath Co.**, Aurora & Solon Rds., Solon, Ohio.

Circle 409 on Page 165

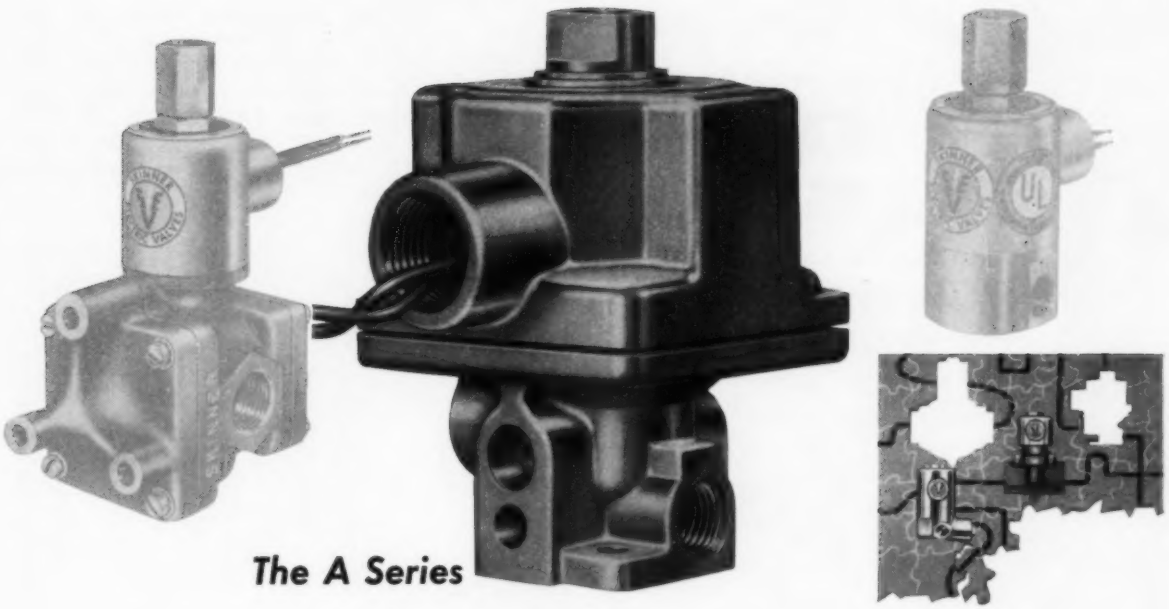


Coining Press

Item 410

Machine is capable of multiple coining operations and the coining of large size or widely separated parts. A double knuckle arrangement, one in front and one in back, gives uniform two-point ram pressure on a 48 by 84-inch bed for heavy tonnage operations. Model K2 has a 1000 ton capacity, is supplied with a nine station front-to-back transfer feed on 9-inch centers. Feed bar centers are adjustable right to left, and provision is made for two feed lines using four bars for coining small parts.

The knuckle assemblies break inward toward each other and are actuated by links from a slide mounted between them. The knuckle suspensions are rigidly mounted on the crown. Adjusting wedges and the adjusting mechanism for the ram are built into the ram. Stroke of the ram is 8 inches, with a motorized adjustment of ½ inch. Utilizing four-piece steel tie-



The A Series

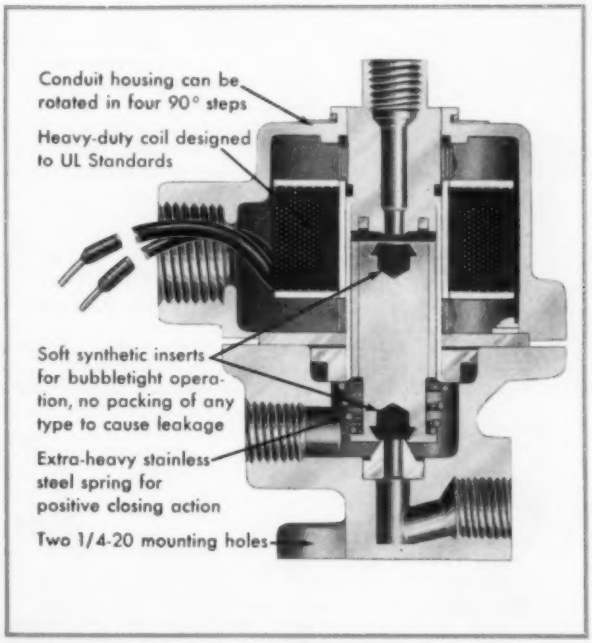
NEW— three-way Skinner Valve line for medium-size cylinders

This new A Series valve line bridges the gap between the famous V5 line used with small cylinders and the reliable M3 line used with large cylinders. The design of this new line permits economical and efficient operation of medium-size cylinders as well as faster operation of smaller cylinders where increased cycling speed is a necessity.

The first of the A Series line is a 3-way normally closed valve with a $\frac{5}{32}$" orifice and $\frac{1}{4}$" NPT ports, and a pressure rating of 125 PSI. It is designed for use with such media as oil, air and inert gases.

Despite the increase in capacity, this new valve is light in weight (only 3 pounds) and compact ($3\frac{7}{8}$" high and $2\frac{5}{8}$" square). The body and mounting are non-corrosive zinc and the internal parts are stainless steel. The plunger is spring-loaded and direct-acting, and the valve can be mounted in any position. Soft synthetic inserts are used, assuring bubbletight operation and long, trouble-free life.

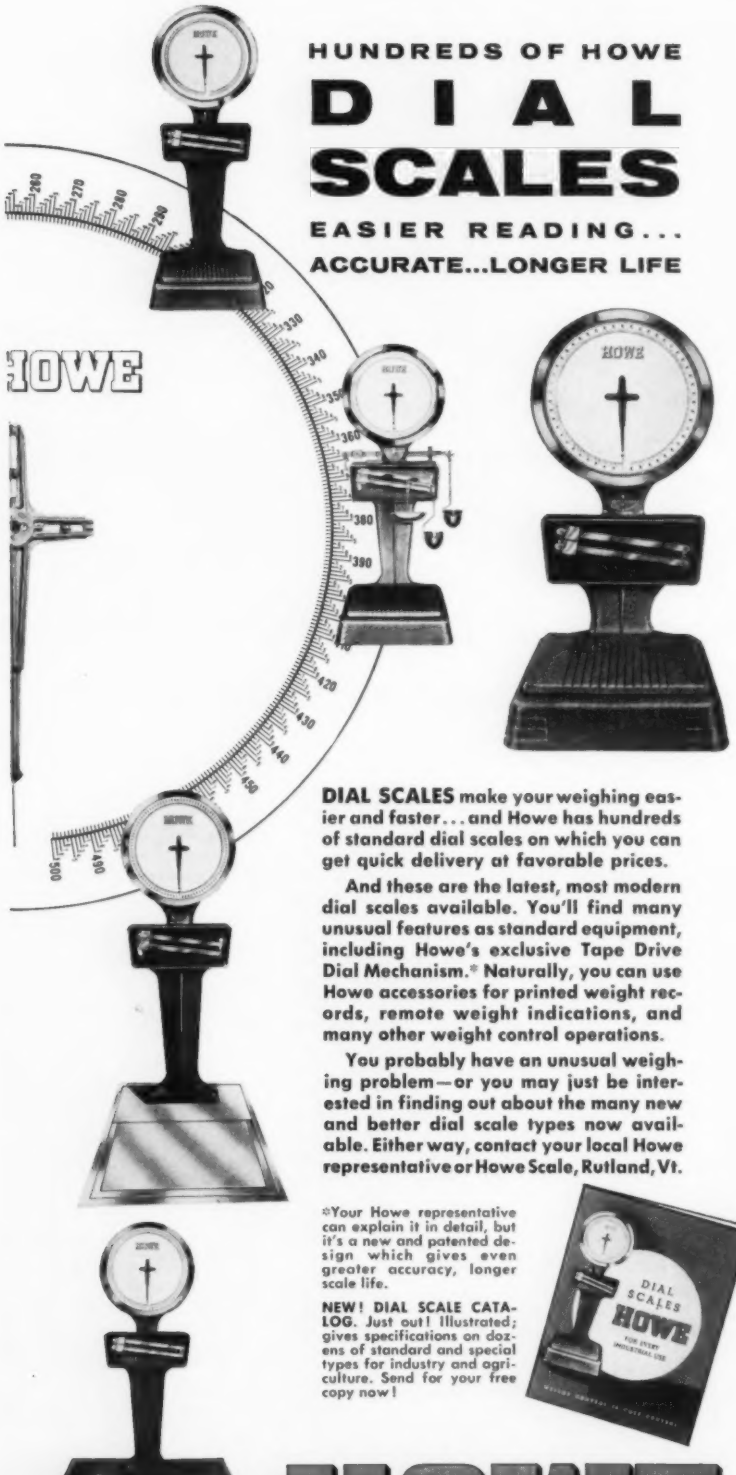
For additional information, options and specifications, call the Skinner Representative or Distributor nearest you – he's listed in the Yellow Pages. Or write us at the address below, Dept. 325


Conduit housing can be rotated in four 90° steps
Heavy-duty coil designed to UL Standards
Soft synthetic inserts for bubbletight operation, no packing of any type to cause leakage
Extra-heavy stainless steel spring for positive closing action
Two 1/4-20 mounting holes

SKINNER ELECTRIC VALVES
THE CREST OF QUALITY

SKINNER ELECTRIC VALVE DIVISION
NEW BRITAIN CONNECTICUT
105 EDGEWOOD AVENUE

Circle 693 on Page 165



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DIAL SCALES

EASIER READING...
ACCURATE...LONGER LIFE

DIAL SCALES make your weighing easier and faster... and Howe has hundreds of standard dial scales on which you can get quick delivery at favorable prices.

And these are the latest, most modern dial scales available. You'll find many unusual features as standard equipment, including Howe's exclusive Tape Drive Dial Mechanism.* Naturally, you can use Howe accessories for printed weight records, remote weight indications, and many other weight control operations.

You probably have an unusual weighing problem—or you may just be interested in finding out about the many new and better dial scale types now available. Either way, contact your local Howe representative or Howe Scale, Rutland, Vt.

*Your Howe representative can explain it in detail, but it's a new and patented design which gives even greater accuracy, longer scale life.

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HOWE

THE HOWE SCALE CO. · RUTLAND, VERMONT
A SUBSIDIARY OF SAFETY INDUSTRIES, INC.

rod construction, press has the clutch and brake arranged so lining inserts can be quickly changed without removing the clutch from the shaft. **Press Div., E. W. Bliss Co.**, 1375 Raff Rd., Canton, Ohio.

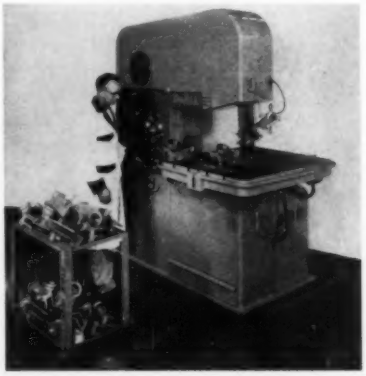
Circle 410 on Page 165

Tab Card Burster

Item 411

Machine is capable of continuously separating tabulating cards at the rate of 600 per minute. It is suitable in operations such as insurance check writing, utility billing, etc. The card burster is available as an attachment to company forms burster-imprinters, or as a complete unit to handle both cards and forms bursting. Switching operation from cards to forms requires 60 seconds. **Uarco Inc.**, 141 W. Jackson Blvd., Chicago 4, Ill.

Circle 411 on Page 165



Bandsaw Table Control

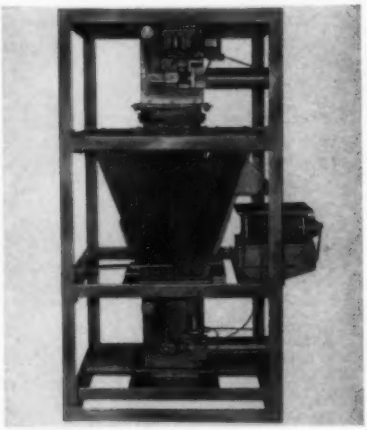
Item 412

Single cycle automatic table return is designed for use on company's band machine. After a sawing or slotting job is set up on the

Circle 694 on Page 165

table, an adjustable trip dog on the table periphery is set for the desired length of cut. In operation, the trip dog engages a limit switch when the table reaches the desired infeed point, actuating a solenoid valve to return the table hydraulically to loading position. The table remains in loading position until the *Cycle Start* button is pressed and another feed stroke begins. Feed rate and pressure are established by the normal table hydraulic controls. Once the controls are adjusted, they are set for the entire production run. The operator is required only to unload and reload the work holding fixture and press the *Cycle Start* button. **DoAll Co.**, Des Plaines, Ill.

Circle 412 on Page 165



Weighing Hopper Scale

Item 413

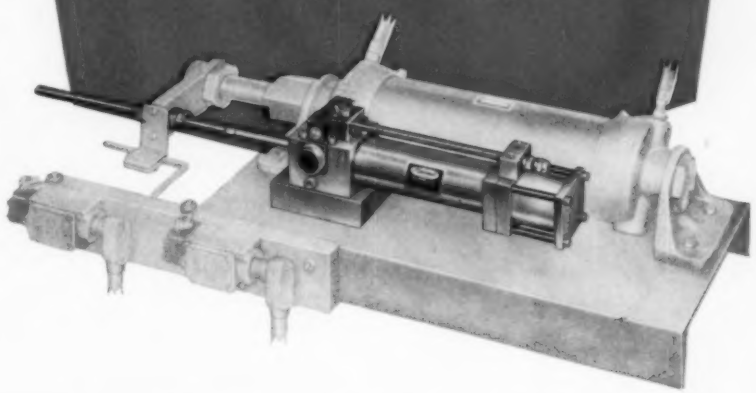
Applicable in automatic batching, blending, or inventory control, instrument can indicate, record, or totalize weight information. Control can be semiautomatic or automatic, and instruments can be located at the scale or in a remote position. Unit consists of a feed, a hopper, and a discharge frame. The feed and discharge frames can accommodate a selection of gate valves, slide gates, screw feeders, vibratory feeders, or similar units. The hopper frame has a flexure-mounted hopper which transmits a vertical force component to a pneumatic or electric weight transmitter. The transmitter is accurate within ± 0.25 per cent of calibrated weight range. Standard hoppers have maximum capacities from 5

Now—Hydraulic Smoothness and Control from your own Air Cylinder plus a

VERI-TROL

TRADE MARK

Hydraulic Checking Cylinder



Designed for use with conventional air cylinders, VERI-TROL hydraulic checking cylinders smooth out stroke variations due to the compressibility of air under irregular load conditions. They're ideally suited for use with air cylinders operating tool or work-piece feeds, precise positioning devices, or wherever you need a smooth, uniform work stroke at any desired pre-set speed. VERI-TROL features (patents applied for) include:

- ACCURATE SPEED CONTROL is dial-set, load-compensated to assure uniform stroke speed even with irregular loads.
- BUILT IN "SKIP," "STOP" OR "SKIP-STOP" controls optional.
- VISIBLE OIL RESERVOIR, easy to refill.
- 2,000 LB. CHECKING CAPACITY on out stroke, free return.
- 2", 4", 6", 9", 12", 15" and 18" checking stroke lengths.

Take the bumps and jumps out of air cylinder operation — install VERI-TROL checking cylinders wherever you want smooth, accurately-controlled stroke speed. Write now for free data bulletin; please address Dept. C-5.

Modernair CORPORATION

400 PREDA ST.,
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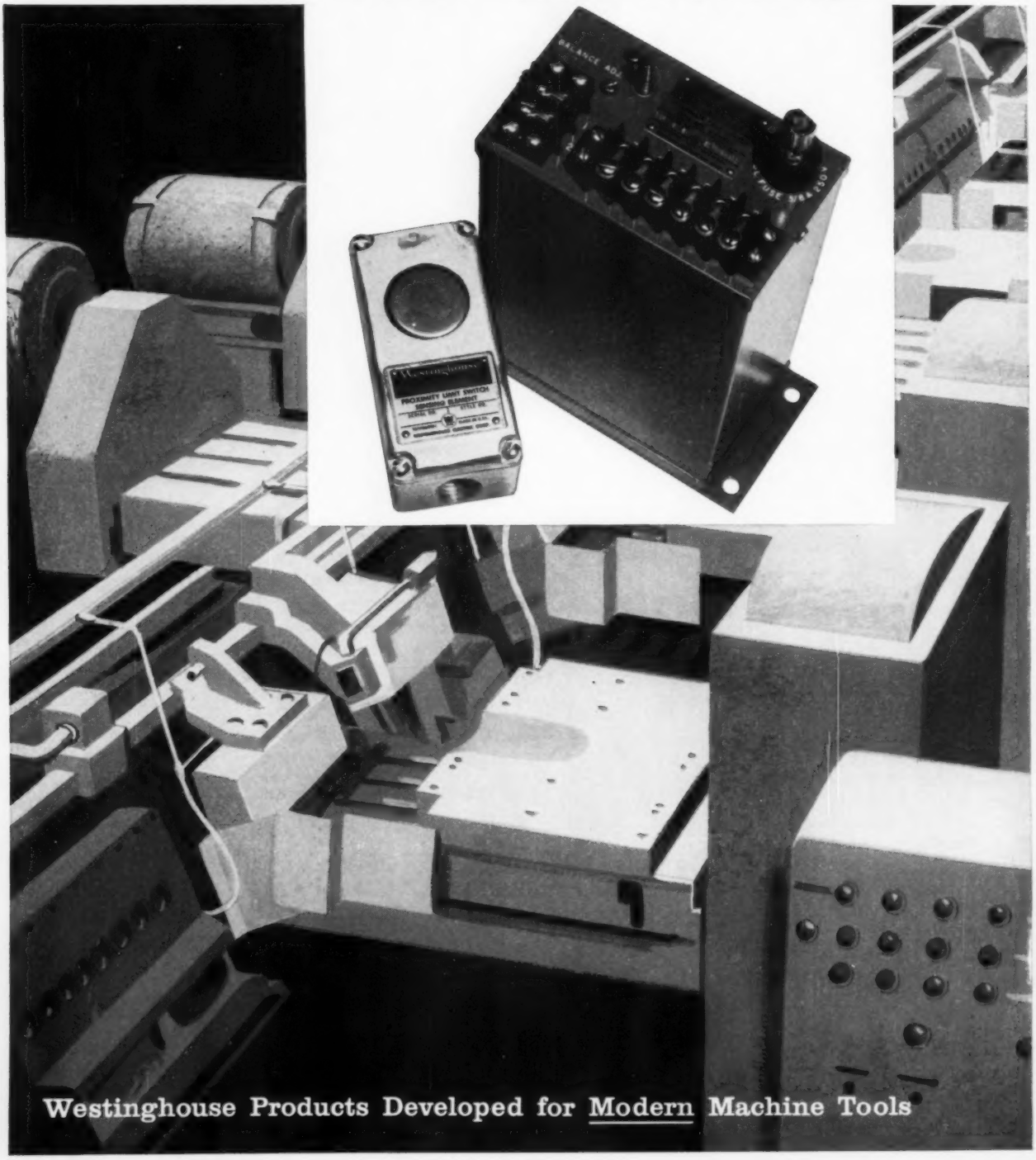
36

MEMBER OF NATIONAL FLUID POWER ASSOCIATION

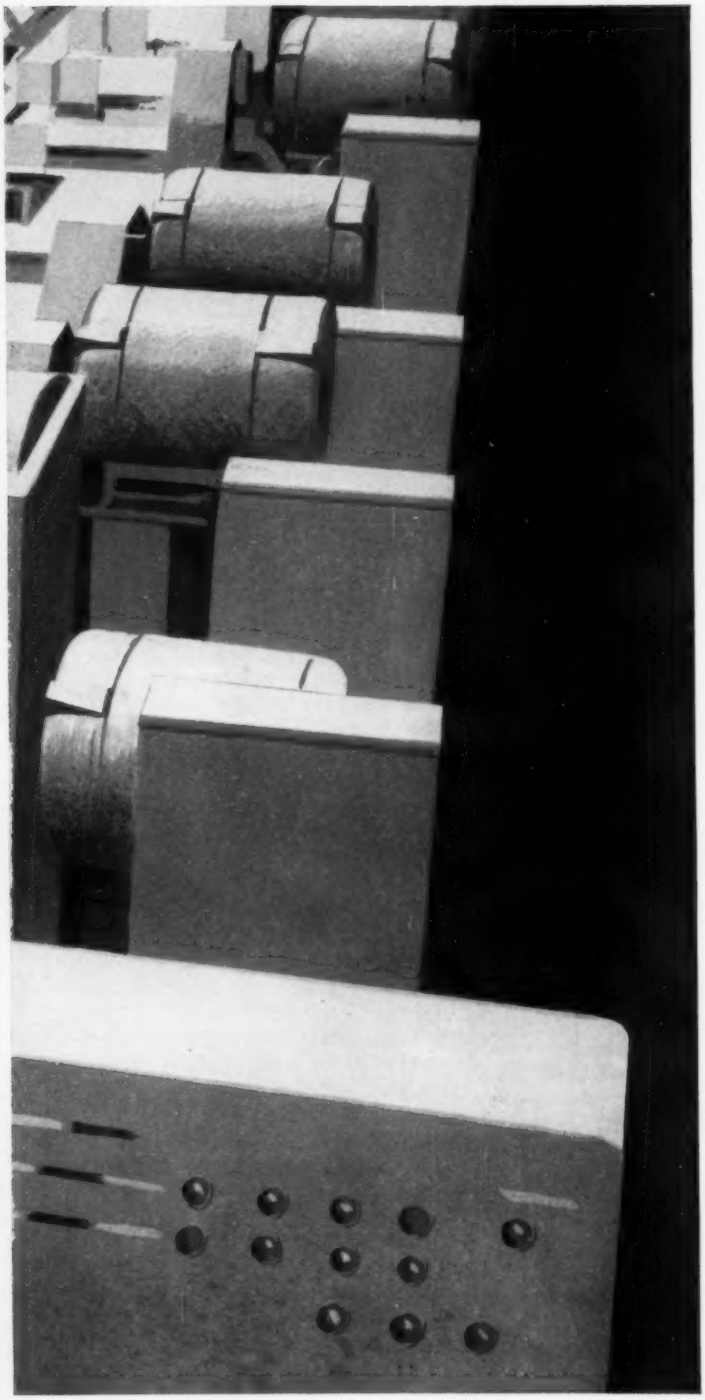
Circle 695 on Page 165

NEW PROXIMITY LIMIT OUTLIVE THE MACHINE IT



Westinghouse Products Developed for Modern Machine Tools

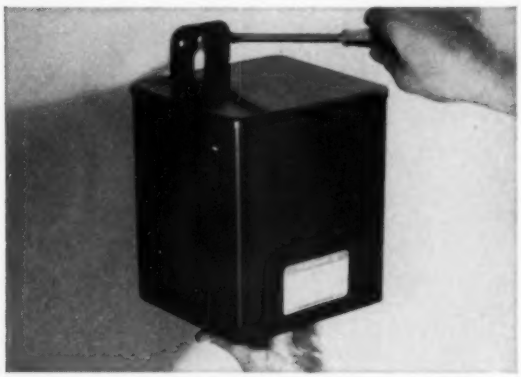
SWITCH WILL CONTROLS



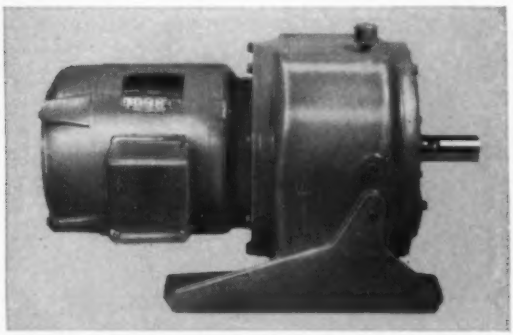
With the elimination of conventional mechanical parts, the new Westinghouse Proximity Limit Switch is the final link in a truly reliable control system. Developed and designed through practical research in Westinghouse engineering facilities, this new product is suitable for a wide range of application in the machine tool industry.

Westinghouse products like this are the sign of a modern machine tool, designed to give the most production at the lowest possible cost. An electrical system, designed and supplied by Westinghouse industry-experienced engineers, is sure to give the best in long-term economical service.

For complete information about Proximity Limit Switches and the other Westinghouse components for modern machine tool systems, ask your Westinghouse sales engineer. Or, write Westinghouse Electric Corporation, P.O. Box 868, 3 Gateway Center, Pittsburgh 30, Pennsylvania. J-96110-R



Westinghouse EP Machine Tool Transformers cut space requirements up to 50%, can be mounted in any position. Accelerated life tests indicate new design doubles normal machine tool transformer life.



New Moduline Gear Units use 15 basic subassemblies to standardize over 20,000 gearing configurations. One wrench modifies any unit. Gears meet AGMA "master-gear" standards for quiet, maintenance-free operation.

YOU CAN BE SURE...IF IT'S

Westinghouse

Circle 696 on Page 165

to 90 cu ft of material. **Weighing & Control Components Inc.**, 321 Lincoln Ave., Hatboro, Pa.

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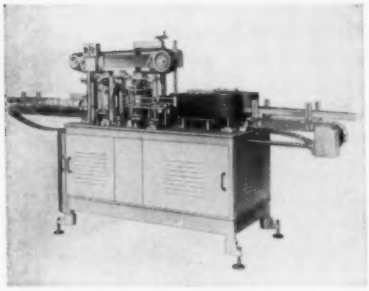

Automatic Labeler

Item 414

Unit applies labels of foil, metal, or paper on containers of glass, cardboard, plastic, and metal. Model CM has a variable speed drive which can be regulated for capacities of from 40 to 150 containers per minute. It can affix single panel labels up to 6 by 8 inches, and wrap-around labels on containers up to 2¼ inches in diameter. For single panel labels, containers ranging from an ounce to a gallon can be handled. Unit is designed for continuous production with a labeling magazine which can have supply replenished while the machine is in operation. **MRM Co.**, 191 Berry St., Brooklyn 11, N. Y.

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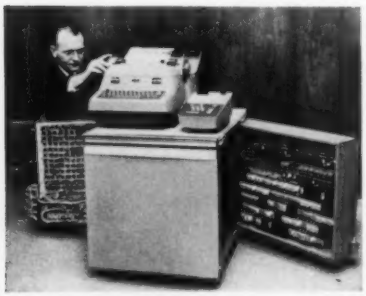


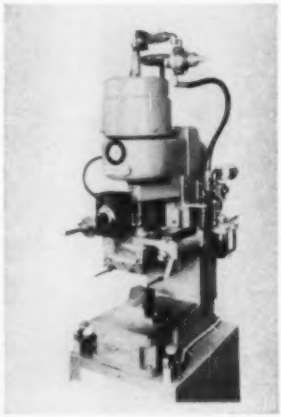
Office Calculator

Item 415

Unit consists of an electric typewriter, a ten-key companion keyboard, a magnetic core memory within a computer unit, and a program reading device. It can be automatically programmed to retain and type out total gross sales, taxes, or other selected accumulations. Model IBM 632 can automatically type, extend, carry totals, compute taxes, subtract discounts, position decimals, justify multidigit numbers, and type-out results. The numerical information, keyed in on the companion keyboard can be added, s u b t r a c t e d, multiplied, rounded off, and held in memory for later processing.

In operation, the information is typed manually on the electric typewriter; entries are made on the companion keyboard, and are typed out automatically by the typewriter; the results of the calculations made and typed out come from the electronic calculator. Instructions and decisions for a complete application are provided by a plastic tape within the program reading device. The tape can be changed for a different office procedure in a few seconds. The typewriter can also be used for general typewriting purposes. **Electric Typewriter Div., International Business Machines Corp.**, 545 Madison Ave., New York 22, N. Y.

Circle 415 on Page 165



Hot Stamping Press

Item 416

Machine is adaptable to use for hot stamping any product of plastic, painted metal, or wood on flat, curved, cylindrical, or other shaped parts. Model 250 has an automatic timer and pressure cycle control unit. Production rate is up to 1,000 hot stamped pieces per hour, depending on the size of the part. The die and type holder has an adjustable and removable slide. Other features include a muffler which decreases air noise, and an overrunning roll leaf advance clutch for the automatic feeding of the roll leaf. Special fixtures for special shapes can be adapted to the press. **Acromark Co.**, 492 Morrell St., Elizabeth, N. J.

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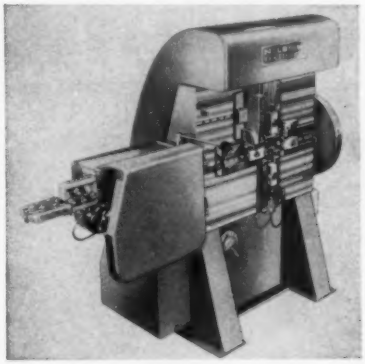


Vertical 4-Slide Former

Item 417

Automatic 4-slide machine can handle both wire and ribbon metal stock; accomplishes the forming operation in a vertical plane. Model V-187 can produce a variety of formed parts to close tolerances at high speeds. Metal is taken directly from the coil, straightened, fed, cut off, and formed. When threading, hollow milling, or chamfering are part of the work required in making a complete wire form, the operations can be included in the forming process.

The unit includes a form moving attachment, a roll type stock straightener, an automatic lubricating system, variable speed drive, handbar safety switch, and a manual electric starter. A driveshaft located behind the face of the machine actuates the forming slides. The forming slide rolls have needle bearings, which are placed in the center of the slides to give a centralized thrust from low-angle barrel cams. They are rigidly mounted in the frame, decreasing shaft deflection. Vertical arrangement of the machine provides for the finished product to be ejected at the front, is adaptable to hopper or magazine feeding, and permits greater accessibility of tooling. Accessory equipment available includes wire and stock reels and press attachments. **A. H. Nilson Machine Co.**, Shelton, Conn.

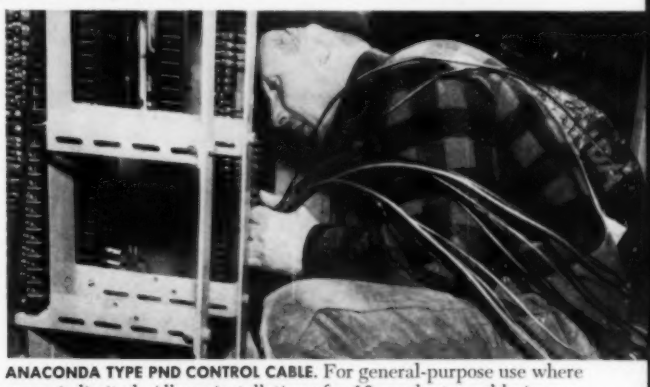
Circle 417 on Page 165

Match the conditions in your plant with these Anaconda Control Cables

ANACONDA TYPE ANW-RUBBER-INSULATED CONTROL CABLE. Peak reliability, outstanding heat resistance. Cable is also highly resistant to moisture, acids, alkalies, other chemicals. Unusual overload capacity and long-aging characteristics. Individual conductor covering and over-all jacket of neoprene.

ANACONDA THERMOPLASTIC CONTROL CABLE. Multiple-use: aerially, in conduit, underground in ducts, direct burial in earth. Available with polyethylene (600 or 1000 volts) or Densheath* vinyl resin (600 volts) insulation and Densheath over-all jacket. Densheath jackets over polyethylene-insulated conductors on request.

ANACONDA BUTYL-INSULATED CONTROL CABLE. Ozone-resistant control cable. Individual conductor covering and over-all jacket of neoprene provide maximum insurance against moisture, mechanical injury. High-quality product with outstanding performance record.



ANACONDA TYPE PND CONTROL CABLE. For general-purpose use where space is limited. Allows installation of a 12-conductor cable in conduit carrying a 6 or 7. Individual conductor covering of abrasion-, oil-, gasoline-resistant nylon. Over-all Densheath jacket.

APPLICATION CHART FOR ANACONDA CONTROL CABLE

TYPE AND VOLTAGE RATING	CHARACTERISTICS	GENERAL APPLICATIONS	INSTALLATION METHODS
RUBBER—Insulated Control Cables			
Rubber-Insulated 600-Volts	Excellent moisture, heat resistance. Long-aging.	General-purpose and station control requirements.	Installed aerially, in conduit, underground in ducts—or buried directly in earth.
Ozone-Resistant Rubber—Insulated 600-Volts	Ozone-resistant. Proved moisture resistance, heat stability Long-aging.		
THERMOPLASTIC—Insulated Control Cables			
Polyethylene-Insulated 600-Volts	Excellent moisture and chemical resistance. Highly resistant to electroendosmosis. Long-lived.	General-purpose control requirements.	Installed aerially, in conduit, underground in ducts—or buried directly in earth.
DENSHEATH®-Insulated 600-Volts	Thermoplastic cable. Excellent moisture and chemical resistance. Long-aging.		
Anaconda Type PND* Polyethylene-Insulated-Nylon Conductor Cover 600-Volts**	Dependable chemical and abrasion resistance. Small diameter. Long-aging.	General-purpose control requirements where space is a limiting factor.	Installed aerially, in conduit or underground in ducts.
Polyethylene-Insulated 1000-Volts	Peak moisture and chemical resistance. Heavy insulation thickness. Long-aging.	Station control requirements.	Installed aerially, in conduit, underground in ducts—or buried directly in earth.

**IPCEA voltage rating is 300 volts.
*Trademark.
Lead sheaths furnished on rubber-insulated control cables if requested.
Interlocked armor available for all types of control cable.

For full facts on any of Anaconda's complete line of control cables – including cables engineered for more specialized control requirements – see your Anaconda distributor or the Man from Anaconda. A comprehensive technical booklet on Anaconda Control Cables is yours for the asking. Write: Anaconda Wire & Cable Company, 25 Broadway, New York 4, N.Y.

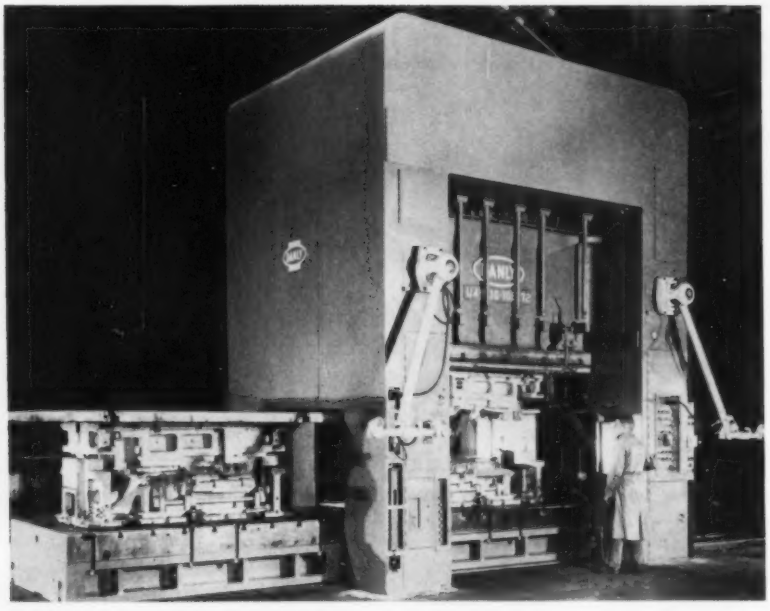
56340

*Reg. U.S. Pat. Off.

LIVE BETTER ELECTRICALLY

SEE THE MAN FROM **ANACONDA®**
FOR **CONTROL CABLE**

Circle 697 on Page 165



Quick Die Change Press for Large Stampings

Item 418

Machine utilizes two moving bolsters which permit die changes to be made in a matter of minutes. Each bolster is mounted on a power driven, heavy duty carrier which makes up the die carrier assembly. The uprights of the press are designed with openings large enough to permit the die carrier and dies to move through the end of the press.

This design permits a set of dies mounted on one die carrier to be running in production while the second set of dies is being set up on the second die carrier. Changing production from one set of dies to another involves moving one die out of the working position and moving the second die carrier and die into the working position from the opposite side.

Procedure for changing dies includes setting the slide at the bottom of its stroke, unclamping the dies from the slide, and running the slide to the top of its stroke. The hydraulic cylinders are raised to raise the die carrier above locating keys, and one die is moved out while the other moves into working position against positive stops. Then the hydraulic cylinder is released to lower the die carrier over the locating keys and the die carrier is fastened to the press bed. The carrect shutheight is dialed on an automatic slide positioner. The slide is brought over the bottom center with a Microinching drive and stops at the bottom of its stroke. The drive is a slow speed, reversible press drive that can be operated independently of the main motor drive, yet can deliver the full rated capacity of the press. Accurate slow speed control of the slide and dies permits progressive penetration of the dies, and backing out the slide as many times as may be necessary for inspecting the stamping or adjusting the dies. This drive runs independently of the flywheel. **Danly Machine Specialties Inc.**, 2100 S. Laramie Ave., Chicago 50, Ill.

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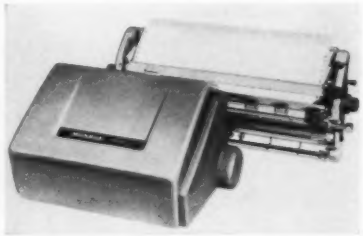

Electric Printer

Item 419

Suitable in the automatic data logging field, electric printing unit is equipped with power supply and control unit. Control unit provides the proper pulse duration, currents and voltages for both keyboard and operation functions. The power supply can operate the printer over a source voltage range of 100 to 125 v. Machine is capable of having a possible entry of up to 14 digits simultaneously, thereby reducing the number of operations required of the system components.

The digits can be entered on one printing cycle, in any arrangement of 1, 2, 3, and up to 14, or in any grouping within 14 digits, such as three groups of four and one group of two. Automatically indexed carriage can be mechanically programmed to tabulate fixed or variable distances after any printout. Carriage has a four position carriage programming arrangement that can be manually set to any one of four different programs. Maximum printing rate is 150 printing operations a minute. **Electronics Components Div., Monroe Calculating Machine Co. Inc.**, 60 Main St., San Francisco, Calif.

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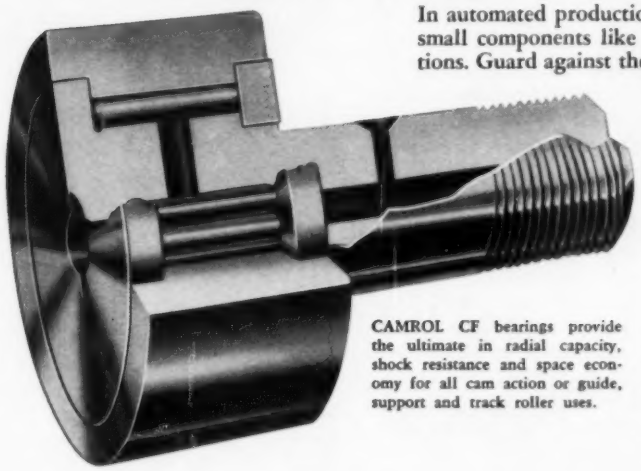
Parts Feeder

Item 420

Device is capable of orienting, feeding, and counting a variety of objects such as ball bearings, ball bearing races, needle bearings, and needle bearing races. Parts such as flanged bottle caps can be oriented and fed at rates in excess of 1,000 per minute. Feeder consists of a flat rotating disc which utilizes centrifugal action to discharge parts in an oriented manner at high speeds. A variable speed drive provides either fast motion for high

AUTOMATION TIPS by McGill

CAMROL® bearings ideally suited to anti-friction requirements of automated machinery

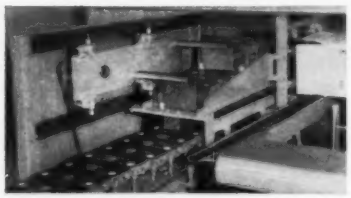


CAMROL CF bearings provide the ultimate in radial capacity, shock resistance and space economy for all cam action or guide, support and track roller uses.

In automated production, even the inefficiency and faulty operation of small components like a cam follower unit can cause costly interruptions. Guard against these failures by specifying CAMROL cam followers. Their quality insures dependability. Their design simplifies lubrication, easily accommodates critical loads and provides low starting and running friction.

Over 20 years of engineering development has gone into the McGill bearing — the first commercial full-type roller bearing cam follower. McGill has employed the advantages of these years of application experience to improve the design and build performance extras into the CAMROL CF, CYR and sealed SCF and SCYR series bearings. All are available in a wide range of standard sizes.

The applications cited below are just a few of the many instances where CAMROL bearings are adding to the dependability of automated machinery.

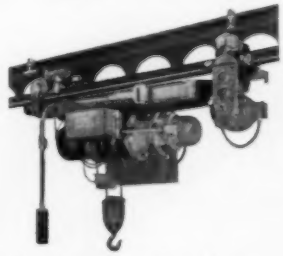


Camrol CF bearings cut power requirements on J. L. Ferguson Co. packaging machines

Used as load-carrying cam followers and as guide rollers in PACKOMATIC packaging machinery, McGill CAMROL CF bearings have brought several desirable advantages to J. L. Ferguson Company in the eight years this firm has relied on CAMROL bearings.

The CAMROL CF bearings eliminate wear by reducing friction. This reduces power requirements and smooths the operation of these machines. The CF bearings are standard, cost less and are more easily applied than previous assemblies.

For trouble-free operation, up to 50 bearings per machine are now used by this company.

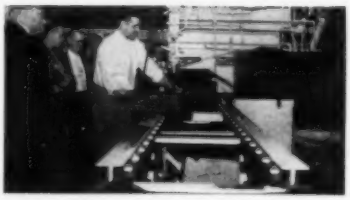


Cleveland Tram Rail guides motor heads on McGILL Camrol Bearings

Motor-driven electric hoist carriers made by the Cleveland Tramrail Division of the Cleveland Crane and Engineering Company, incorporate McGill CAMROL Cam Follower bearings as side guide rollers for the motor head.

Replacing spring loaded friction type bolt or roller units, the CAMROL cam followers provide dependable, free running operation of the carrier assembly and provide simplicity of mounting and lubrication with trouble-free performance.

Bearing performance has been most satisfactory through almost six years of use.



Camrol CF bearings provide friction-free track rollers for automatic mold blower

McGill CAMROL CF rollers are used as track rollers to form a mold conveyor in the Beardsley & Piper MBS-20 Mold Blower. The CAMROL CF bearings replaced built up friction rollers in this application. Although the duty here is rather light and the speeds slow, the cam follower bearing provides less starting and running friction. This helps speed the even flow of work from the machine, which must be fast and automatic. The compact unit, with integral stud, simplifies assembly and lubrication. Availability of a standard bearing is more convenient and less costly.

SEND FOR CATALOG 52-A

Insure performance with McGILL®

MULTIROL® GUIDEROL® CAMROL®
Precision Needle Bearings

McGILL MANUFACTURING COMPANY, INC., 401 N. LAFAYETTE ST., VALPARAISO, INDIANA

speed feeding and counting or very slow motion for gentle handling of delicate parts. The unit can be tooled to handle a wide variety of parts for many different applications. The discharge track can be horizontal or it can be curved into a vertical direction to feed into assembly machines, or for other operations. It can be used to feed parts into machines or it can be used for straight counting or for batching. **U. S. Engineering Co.**, 40-28 22nd St., Long Island City, N. Y.

Circle 420 on Page 165

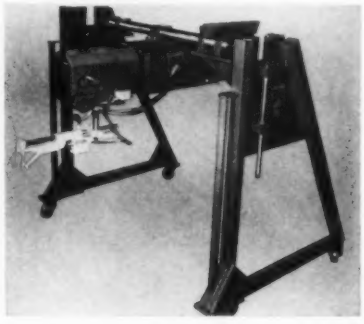
Socket Setscrew Driver

Item 421

Machine automatically feeds, inserts, and tightens socket set-screws ranging in diameter from No. 6 up to $\frac{3}{8}$ inch, in lengths up to $\frac{3}{4}$ inch. Unit can make up to 2500 complete installations an hour in as many different product assemblies. It can be used as an attachment to a single machine or as an integral unit in an automated production line. Set up for semiautomatic operation, the machine can install setscrews in parts fed to it by hand.

The Setomatic consists of two basic units: A screw-supply system which picks up screws from a supply hopper, orients them and feeds them into a driver-feed tube; and a drive mechanism which picks up the screws from the feed tube, inserts them into tapped holes and tightens them to a preset, controlled torque. The socket setscrew is a hollow, headless type. In operation, setscrews are dumped in bulk into the vibrating hopper at the top of the machine. A spiral track built into the sides of the hopper picks up the screws and carries them to the top of the feed tube. At the mouth of the tube, a selector fitted with a pin passes screws that are properly oriented and pushes screws that are pointing the wrong way back into the hopper. Screws are fed by air pressure through the tube to the driving unit. When the tube is filled, the feeder unit automatically stops. It resumes operation when the supply of screws in the tube drops below a predetermined level. If a hole is poorly tapped, a slip clutch on the drive spindle stops the driver from rotating and a cam returns the driver to its start position. Screws can be installed vertically, horizontally, or at any angle. Two machines can be mounted at 90 degrees to each other to permit two screws to be installed simultaneously with a single control. **Standard Pressed Steel Co.**, Jenkintown, Pa.

Circle 421 on Page 165

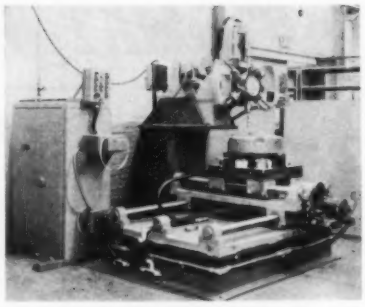


Press Extractor

Item 422

Horizontal unloader can be mounted upright on a press, conveyor, or an adjustable rollaway base. With the jaw assembly removed, it can be used as a power unit for a parts feeder or transfer mechanism. A geared nonslip belt is used in place of roller chains or racks and pinions. The jaw assembly is adjustable and permits grabbing of the piece at any angle. The cylinder cushions are extra long for smooth extracting action, and the track is designed to shed dirt and other foreign matter. **Sahlin Engineering Co. Inc.**, P.O. Box 289, Birmingham, Mich.

Circle 422 on Page 165

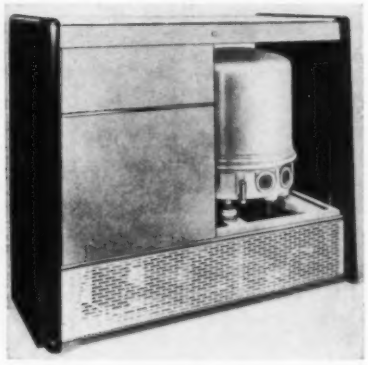


Tape Controlled Drive

Item 423

Applicable in drilling and tapping operations, unit includes a ball bushing positioning table and a numerical tape controlled drilling machine. Display unit demonstrates application of "building-block" concept in fabrication of special purpose production equipment, using company's line of precision spindles, slides, and feeds. Cycle of operation of demonstration setup includes reading of prints, typing of tapes, reading of the tape, and the machining operation as dictated by the tape. A welded base supplies support for the positioning table, and a column provides a support for the spindle. **Standard Electrical Tool Co.**, 2010 River Rd., Cincinnati 4, Ohio.

Circle 423 on Page 165



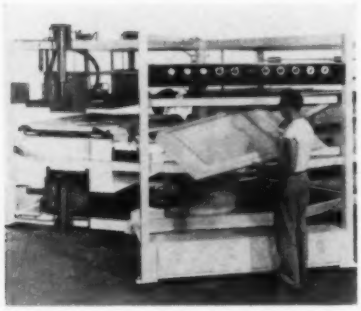
Data Storage Unit

Item 424

Equipment holds 1040 bits per inch, has 320 tracks, and stores a total of 15 million bits. Access time to stored data averages 180 milliseconds. Unit consists of a file drum, drive and lubrication systems, a 3 by 10 by 10 track selection mercury relay matrix, a linear read-out preamplifier, and a final

writing amplifier. The drum, balanced at 1200 rpm, is ground and lapped to a surface finish better than one microinch rms. The operating faces of each double head are optically ground and lapped so that the two surfaces are flat and coplanar to one wavelength of light. **Computer Products Div., Laboratory for Electronics Inc.**, 141 Malden St., Boston 18, Mass.

Circle 424 on Page 165



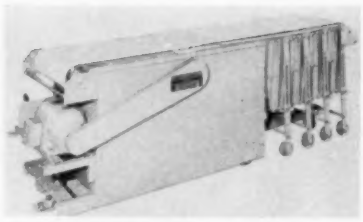
Vacuum Forming Machine

Item 425

Unit vacuum forms products such as concrete forms, refrigerator liners, large tanks, and containers fabricated of heavy gage thermoplastic sheeting. Machine works on a three-stage principle. The operator remains at one station where a finished form is unloaded and a clamp-frame is reloaded with a plastic sheet. During this operation, a sheet is being vacuum formed at the third stage.

Heating and forming operations are automatic. After loading, the carriage carrying the clamp-frame automatically indexes to the heating stage, the heated sheet goes to the forming stage, and a finished product arrives at the operator position. The forming station contains upper and lower platens with 20-inch stroke. Each platen is independently controlled and either one can be switched out of operation, delayed, or timer-returned before the completion of the cycle. Each platen can be supplied with air pressure for blow and pressure forming as well as vacuum. The cycle may be set to supply air pressure, vacuum, and air eject in sequence during a single forming cycle, as for the billow forming process. **Comet Industries**, 9865 Franklin Ave., Franklin Park, Ill.

Circle 425 on Page 165



Extendible Conveyor

Item 426

Portable unit is suitable for use on trailer trucks, boxcars, warehouses, across platforms, or any location where the point of discharge is often changed. The extendible portion of the conveyor bed is full width and extends beyond the edge of the belt and over a link arm connection. The portable belt conveyor can be quickly extended or retracted; for loading purposes, it can be extended full-length to deliver to the far end of a boxcar and retracted as the boxcar becomes filled. **Standard Conveyor Co.**, North St. Paul 9, Minn.

Circle 426 on Page 165

GEM-17 DIAL INDEX TABLE

TRUE GENEVA MOTION

FOR FAST, *ACCURATE* AUTOMATION OF ASSEMBLY *and* MACHINING OPERATIONS

This new, high precision index table is accurate to plus or minus 0.001 in. on a 13 in. dia. work circle; can position work in as little as ½ sec.; indexes a 1,000 lb. fixture load.

BASIC SPECIFICATIONS: Standard Number of Stations—6, 8 or 12; 3 and 4 skip. Motor—Rotary air, fluid, or electric. Dial Plate—17 in. dia. standard; larger plates available. Rotation—Either direction. Interlock—Limit switch operated directly off locking bolt. Weight—200 lbs.

Gray engineers will help you adapt GEM-17 to your use. For recommendations, send specifications of your application. Illustrated brochure GE-21 and prices on request.

GRAY EQUIPMENT COMPANY

13600 Ford Road • Dearborn, Michigan • Telephone: TIffany 6-7573

Circle 699 on Page 165

Post Decitron
electronic products

Model MC

Post's Multi-Channel Input unit . . . accumulates "counts" from several different production lines where total count is desired, utilizes separate photoheads for each line. Anti-coincidence circuit keeps count accurate even if objects on two different lines break beam simultaneously.

Model SD-IT

Outmodes all mechanical counters. Capable of operating at speeds up to 100 units per second. Single "count" indicated on the six digit totalizer as each *tenth* item breaks the light beam. Counts dozens or gross with 12 place counting tube.

Model PW-5

Preset electronic counter with built in warning system. Available in models for counts of 1-100 (PW-2) to model with range 1-100,000 (PW-5). Will count in batches. Warning device may be used to coordinate secondary circuit just before desired count is reached. Will stop machine, cut, divert or perform any other operation. Automatically resets to zero when preset number is reached.

POST ELECTRONICS

Division of Post Machinery Co.
160 Elliott St., Beverly, Mass.

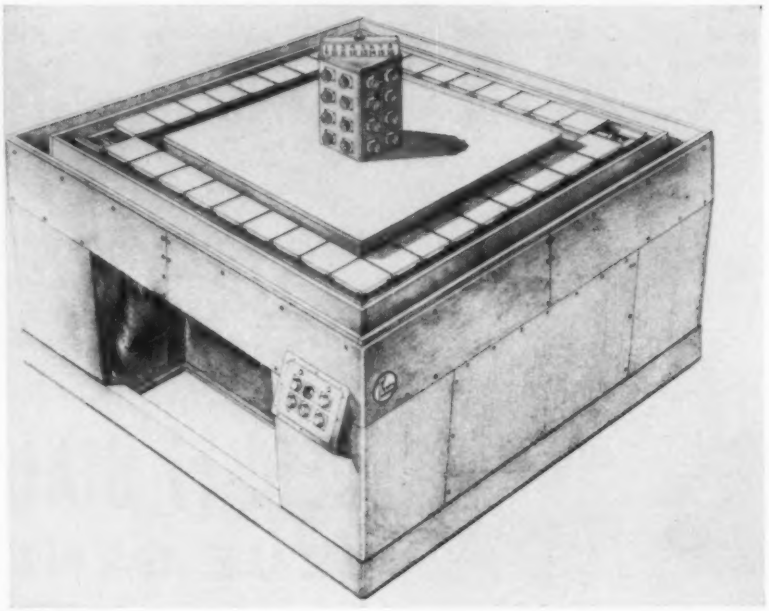
Decitron

POST ELECTRONICS
Division of Post Machinery Co.
160 Elliott St., Beverly, Mass.

☐ Send literature on Model_____
☐ Please send name of nearest representative

Name_____
Company_____
Address_____
City_____ State_____

Circle 700 on Page 165



Transfer Machine

Item 427

Machine features four-sided operation for all applications; has tool mounting surfaces outside and inside the line of travel of the separate pallets. This arrangement permits alternate stations to have the tooling mounted on the outer deck, and the inner deck for free access around all stations. Operations can also be performed from the undersides of the pallets. All station wiring connectors are located at the top of the column wireway at the center of the machine. A *Fault* light indicator is mounted at the top of the column, is visible on all four sides. Design is said to have less inertia than equivalent size rotary indexing units, and thus higher permissible indexing rates.

Mounting rails are provided on the outer deck for portable tools and power heads. An automatic, master, single-dial electrical control unit actuates all machine and tooling circuits at full range of variable speed of work cycle. This unit can be mounted within the base of the machine, or at a remote position. When complete tooling changes are made, no wiring changes are required. Unit is capable of handling a different product on each side of the machine at the same time, with the use of pallets with four work nests. When only one side of the machine is needed for work, the tools on the other three sides can be switched *Off*. **Kenhos Corp.**, P.O. Box 3, Noroton Heights, Darien, Conn.

Circle 427 on Page 165

Tape Punch & Duplicator

Item 428

Device consists of two units; a tape punch and tape duplicator. Tape can present 80 bits of information at each unit advance by simultaneous reading of 10 transverse rows of 8 holes each on company's tape reader. The operator sets up an entire eight-hole line on pushbuttons which illuminate when pressed. The line can be changed or corrected before the

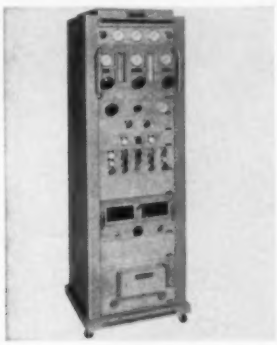
command to punch is given. Tape advances 0.1 inch when punched, and a counter indicates the number of lines that have been completed. The duplicator automatically reproduces copies of tapes by co-ordinating the punch with the reader. For desk-top or typewriter-stand use, the punch can be placed on top of the duplicator. **California Technical Industries, Div., Textron Inc.**, 1415 Old County Rd., Belmont, Calif.

Circle 428 on Page 165

Metallizing Control

Item 429

Device controls automatic production line metallizing. System automatically regulates all functions necessary in starting and operating the metallizing gun such as hoseline purging, selecting the proper



gas and oxygen flows for lighting, ignition, resetting flows for metal spraying or idling, and control of wire feed speeds. All operations are controlled from a remote pushbutton control station. Spraying speed can be adjusted from this station also.

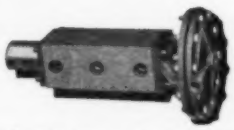
When the pressure controls have been adjusted to optimum pressure and flow conditions, the equipment can be started and restarted without changing the settings. Provision is made for automatic idling of the spraying equipment during interruptions in the supply of workpieces or at intervals during indexing cycles. If the air, oxygen, or fuel gas supply is interrupted, the gun is automatically shut off. A flame-sensing device shuts down the entire system and sounds a warning if the flame becomes arrested. **Metallizing Engineering Co. Inc.**, 1101 Prospect Ave., Westbury, L. I., N. Y.

Circle 429 on Page 165

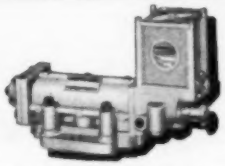
Can YOU afford
to overlook the lower costs increased efficiency and dependability other plants are getting with

Quick-As-Wink®
AIR AND HYDRAULIC
Control Valves

8" Double Pilot Operated 2-way Valve for Plant Water Systems; Pressures to 250 psi.



½" Diaphragm Operated Single Plunger 4-way Air or Hydraulic Valve; Pressures to 250 psi.



½" Single Solenoid 4-way Air Valve; Pressures to 125 psi; (Conforms to "JIC" Standards).

1" Hand Operated 4-way Hydraulic Valve for Oil or Water Service; Pressures to 2,000 psi.

Quick-As-Wink Control Valves are precision instruments:— unsurpassed for controlling all single or sequence machine movements. They are designed better — and made better — to give users unsurpassed efficiency, economy and satisfaction — free from breakdowns. Serviced easily and quickly — in the field — without disturbing any piping. No need to carry large stand-by inventories — or to return valves to the factory for servicing. Hundreds of different types, sizes and actions, including "JIC" designs. Sizes from ¼" to 4". You'll never know how good they are until you try them . . . *Get full details.*

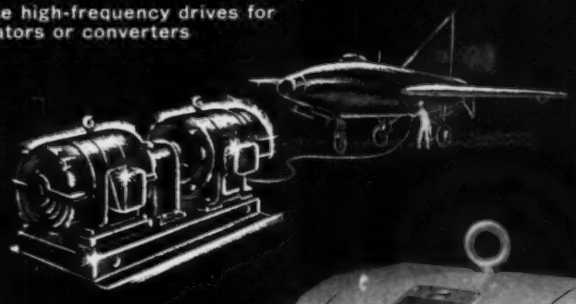
Write for **BULLETIN NO. 571** *Today.*

Quick-As-Wink®
AIR AND HYDRAULIC
Control Valves

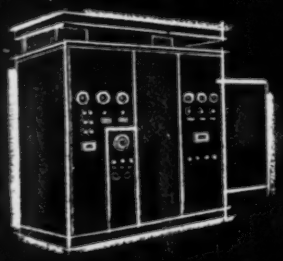
***Mfd. by* C. B. HUNT & SON, INC., 2076 East Pershing St., Salem, Ohio**
— Engineering and Sales Representatives in the Principal Cities —

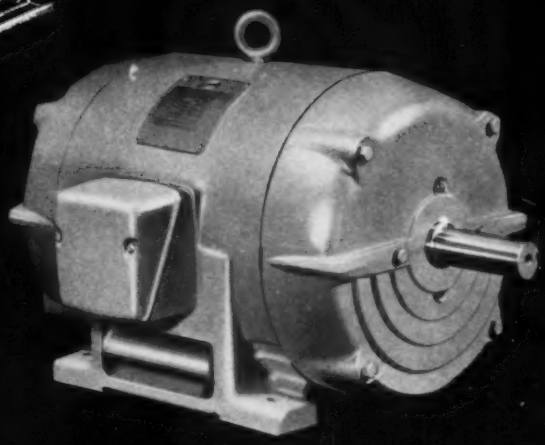
Circle 701 on Page 165

1 Precise high-frequency drives for generators or converters

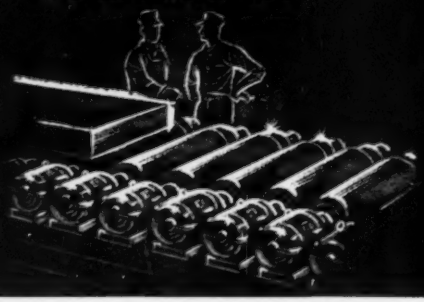


2 Precise timing, metering, and recording devices

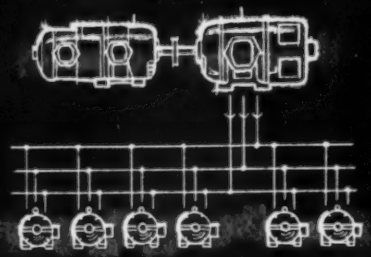




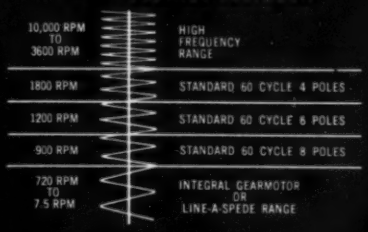
3 Constant single- or multi-speed conveyor drives



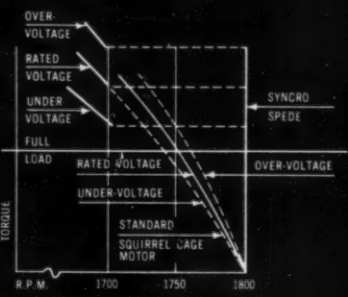
4 Adjustable frequency multi-motor systems



6 High speed — high frequency operation



5 Any constant speed requirement



The Louis Allis Syncro-Spede

a synchronous motor built in the same NEMA frames as standard motors of equal horsepower!

It's compact, simple, versatile . . . and trouble-free!

The remarkable Louis Allis Syncro-Spede® Motor enables you to provide exact synchronous speed for *any* application for less cost — with fewer controls — and in less space than previously possible.

If your equipment or operation calls for precise constant speed, check the advantages this new motor offers you:

Space-saving design — The revolutionary Syncro-Spede needs no external excitation, wound rotating fields, collector rings or brushes. It's built in the same standard NEMA frames as ordinary induction motors of equal horsepower. It requires less space — is virtually maintenance-free.

Wide range of enclosures — The Syncro-Spede can be provided in a wide variety of enclosures to meet special operating requirements. For example, Syncro-Spede is readily available in totally-enclosed fan-cooled and explosion proof enclosures — thus permitting installations which were difficult to make with D.C. excited synchronous motors.

Unmatched versatility — Syncro-Spede is available in standard sizes up to 100 hp, and even larger ratings for special applications. It can also be furnished in a wide range of mechanical modifications . . . base- or flange-mounted—as a gearmotor or brakemotor—even as a rolled-shell shaftless motor for "built-in" applications.

For full particulars and expert application engineering help, contact your local Louis Allis District Office. Or write for Bulletin No. 1900 to The Louis Allis Co., 463 East Stewart Street, Milwaukee 1, Wisconsin.

LOUIS ALLIS

LA-143

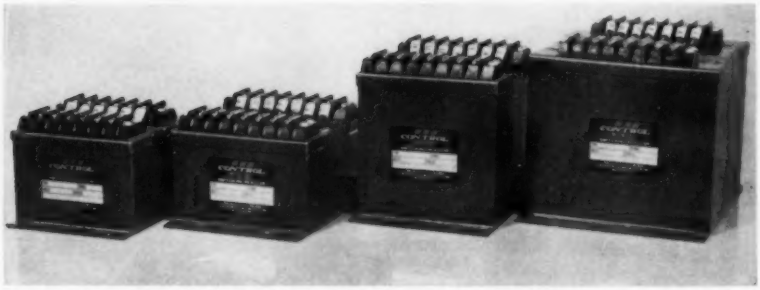
MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

Circle 702 on Page 165

AUTOMATION new components

Parts, elements and devices designed for creating more automatic systems

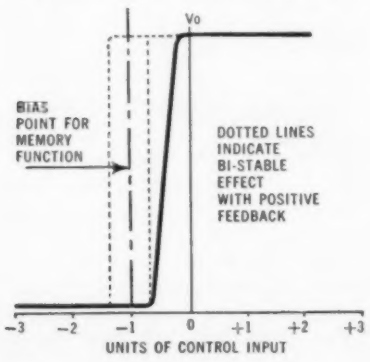
For detailed information and literature, use card on page 165.



Contactless Switching Reactors

EACH power switching reactor in line offered by **Control Div., Magnetics Inc.**, Butler, Pa., can be used interchangeably for various basic logic functions in control systems. Contactless switching action is based on impedance changes induced by dc control signals applied to control windings. The changes in impedance control flow of ac current in the load windings. This ac output may be rectified.

No preamplification of control signals is needed, and inexpensive selenium rectifiers may be used to convert available ac signals to dc for introduction to control windings. Inputs may be derived from limit switches, pushbuttons, or other reactors. Output is of sufficient magnitude to drive solenoids, motor contractors, magnetic clutches, indicator lights, or annunciators.


Vo
BIAS POINT FOR MEMORY FUNCTION
DOTTED LINES INDICATE BI-STABLE EFFECT WITH POSITIVE FEEDBACK
−3 −2 −1 0 +1 +2 +3
UNITS OF CONTROL INPUT

Basic logic functions such as *OR, AND, NOT, Memory,* and *Time Delay* are easily effected as illustrated by the input/output characteristic curve example. An *OR* function, for example, may be established by placing a steady dc bias of −1 control unit (about 20 ma) on a control winding. This assures quiescence, or a condition of negligible output. Any positive control signal of one unit or more from source A, B, or C, etc. will then overcome the bias and turn the unit on.

For 2-input *AND* action, the unit is biased at − 2 control units. Positive signals from sources A and B, or B and C, etc. then may be added to cancel bias and turn the unit on. Unit may safely be biased to − 4 control units, and source signals may be added until total current reaches 80 ma.

NOT action implies that output will cease when a control signal is applied. For this function no bias is needed (zero on diagram). Introduction of a negative control signal of one unit or more will turn the unit off.

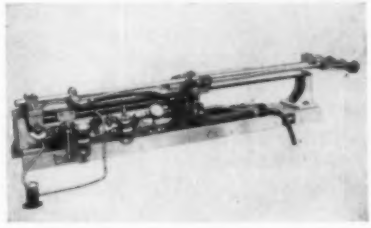
A so-called *AND NOT* action can also be produced. For example, assume a bias of + 1, and unit negative control signals contributed by sources A and B. Application of signals A and B will then produce a resultant bias of − 1, cutting the unit off.

Memory action requires feedback derived from the output. With the unit biased at − 1, one positive control signal, which may be a pulse, will turn the unit on. Resulting generation of a positive unit of feedback will maintain output even after the initiating control signal is removed. One negative signal unit, either sustained or in pulse form, will turn the unit off.

Time Delay is produced through the action of external capacitor networks.

Standard switching reactors are available in four output ratings of 15, 75, 150 and 300 va. One group of four units operates from nominal supply voltage; another group delivers standard load voltages.

Circle 430 on Page 165



Spray Lubricator

Item 431

Unit can automatically spray lubricant on dies, molds, punches, plungers, and mandrels on presses, upsetters, rolls, and hammers. Device covers parted dies, molds, or other production machine tool areas, sprays in a preadjusted pattern in irregular cavities and returns to starting position. Combi-

nations of *Fast-Reach, Slow-Return, Slow-Reach,* and *Fast-Return* are furnished. Five spray nozzles in any position for various patterns, volume, duration, density, and travel are available.

Spray will automatically operate through the complete cycle by pushing or hitting a palm actuating valve; by tripping a cam valve mounted on the machine; or by means of a limit switch or solenoid valve. **Renite Co.**, P.O. Box 8065, Columbus 1, Ohio.

Circle 431 on Page 165

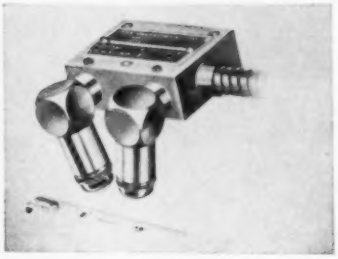
Automatic Program Unit

Item 432

Device provides programmed automatic control for high potential insulation testers. As the line voltage is fed to the high-pot tester, the programmer produces a system in which test voltages are automatically applied to components under test at a uniform controlled rate, giving each component an identical, precisely controlled test.

The unit plugs into the line between the voltage source and the high-pot tester. In one complete cycle the programmer starts at zero volts output and rises at a uniform rate to full voltage output in 6.5 seconds, dwells at full voltage for a preselected time period of from 1 to 60 seconds, and returns to zero voltage at a uniform rate in 6 seconds. A memory circuit prevents application of an output surge should the line voltage be interrupted during the cycle. When this happens, the output voltage remains at zero and the unit cycles to *Start* before voltage can be applied again. Instrument operates on a 115 v, 60 cycle line; output current is 3.5 amps. **Jackson Electronic & Mfg. Co.**, 695 Johnston St., Akron 6, Ohio.

Circle 432 on Page 165

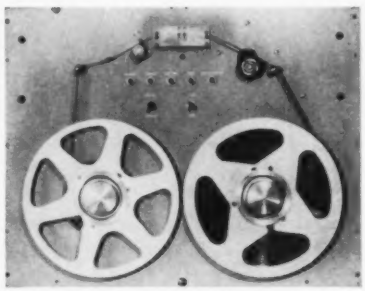


Photoelectric Head

Item 433

Suitable on units such as forming machines, photoelectric cell is set slightly above the thickness of the sheet to detect double feeding of sheet stock into presses. The photo unit is screened and exposed only to light reflected from the surface of the sheet stock. Adjustments on the control relay are set to pass only the sheets that properly reflect light. With proper light reflection the feed of the sheet stock is clear. If another sheet is inserted, light is cut off and a reject signal or control relay is actuated. The relay sets a *Stop* signal or a *Stop* mechanism. **Ess Instrument Co.**, Bergenfield, N. J.

Circle 433 on Page 165

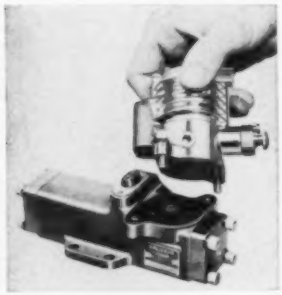


Magnetic Tape Handler

Item 434

Device is designed for forward and reverse operation at speeds of 7.5 and 3.75 inches per second. It offers fast forward and rewind speeds of 1200 fpm. In operation, the tape handler goes into high speed rewind automatically when the rear end-of-tape strip is detected. Upon completion of rewind, the tape is stopped and repositioned for another program cycle when the front end-of-tape is detected. Device for over-riding for normal rewind to change the tape reel is provided. In starting forward and reverse play phases of operation, full speed is attained within one inch of tape travel. **Data-Tronics Div., American Electronics Inc.**, 655 W. Washington Blvd., Los Angeles 15, Calif.

Circle 434 on Page 165



Plug-In Valve

Item 435

Designed for the control of small devices, ¼-in. 4-way air valve features a built-in plug connector for automatic connection of solenoid circuits. All electrical circuits are automatically completed when the unit is placed in mounting position. Permanent wiring connections, made in the manifold or sub-base at the time of original machine assembly, need not be disturbed during in-service maintenance. Solenoid pilots are interchangeable between single and double solenoid types, and are offered with coils for ac or dc, any voltage. Unit, which is available for manifold or sub-base mounting uses no springs in the main valve body; the pilot plungers and valve stem are the only moving parts. Designed for 30 to 250 psi service, the valve has a life that exceeds 25 million cycles. **Valvair Corp.**, 454 Morgan Ave., Akron, Ohio.

Circle 435 on Page 165

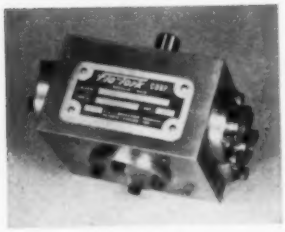
Indicator Light

Item 436

Bushings and lens cap of indicator light are oiltight, watertight, and dusttight. Suitable for heavy-duty industrial applications, unit features high impact phenolic insulation, compact shape, and a rugged construction to withstand severe vibration conditions. A built-in resistor permits voltage up to 250v. Four types of lens, fluted

(shown), plain, unfrosted, or frosted back, are available in seven colors. Terminals can be either screw type or soldering type. **Dialight Corp.**, 60 Stewart Ave., Brooklyn 37, N. Y.

Circle 436 on Page 165

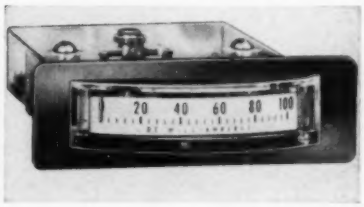


Rotary Actuator

Item 437

Oscillating device is applicable wherever reversible limited rotary motions are required. Standard models give 90, 180, 270, or 360-degree rotations. Rotations up to 720 degrees can be provided. Actuator has positive control in any position and at any point in arc of travel. It can be operated by oil, air, gas, or water pressure. Circular O-ring seals are used. Torque is constant at all positions throughout the arc of travel. All moving parts are bathed by oil in a center chamber, which is sealed independently from the operating pressure media. **Flo-Tork Corp.**, Orrville, Ohio.

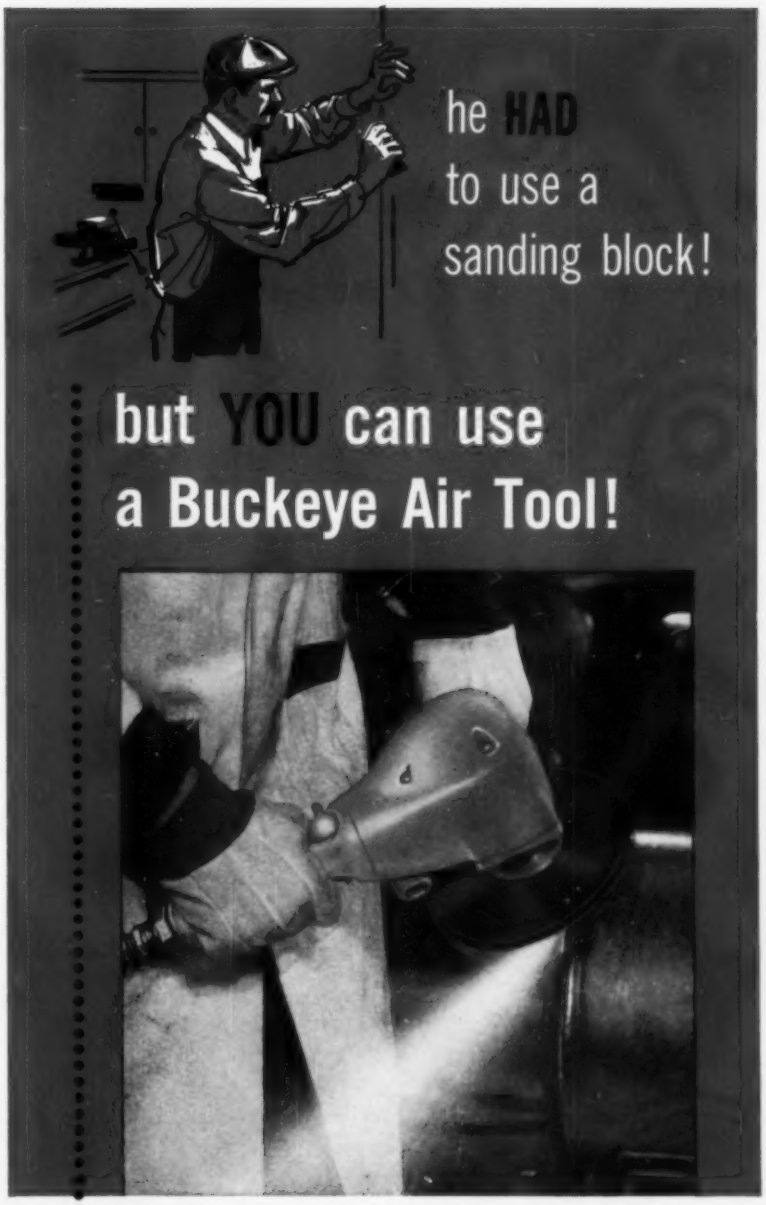
Circle 437 on Page 165



Panel Meter

Item 438

Instrument features a self-shielded core magnet meter movement, can be adapted for use as



Why AIR Tools?

Because air is everywhere, just waiting to be put to work . . . because continuous operation can't possibly harm an air tool . . . and because, if you're using Buckeye air tools, you can almost forget about tool maintenance.

There was a time when muscle power—and plenty of it—was needed to finish off a smooth surface. Today, air power, directed through a Buckeye tool, has replaced muscle power. The work gets done faster, naturally . . . and better, of course.

We don't imagine you're still using a wood block and emery cloth, but it's just possible you're not using a modern Buckeye air tool. And that's the only way you can be sure you're doing your finishing work the best and most economical way.

Our Catalog A-10 contains complete information on the entire line of Buckeye abrasive tools, all of it both interesting and helpful to all portable tool users. If you don't have a copy, send us your name, company and address and we'll correct that situation promptly.

In Air Tools, Your Best Buy Is Buckeye

Buckeye Tools
CORPORATION
DIVISION 12 • DAYTON 1, OHIO

Circle 703 on Page 165

new 4-spindle **BARNESDRIL** automatic programming machine

saves 74% set-up, machining time

machine 248 holes in compressor case
in 4½ hours complete

drill, spotface, bore, ream, tap, chamfer-
up to 4 operations per hole

Tremendous savings are obtained in production time, efficiency, operator judgment and work acceptability in machining compressor casings on this New BarnesdriL Automatic Programming Machine.

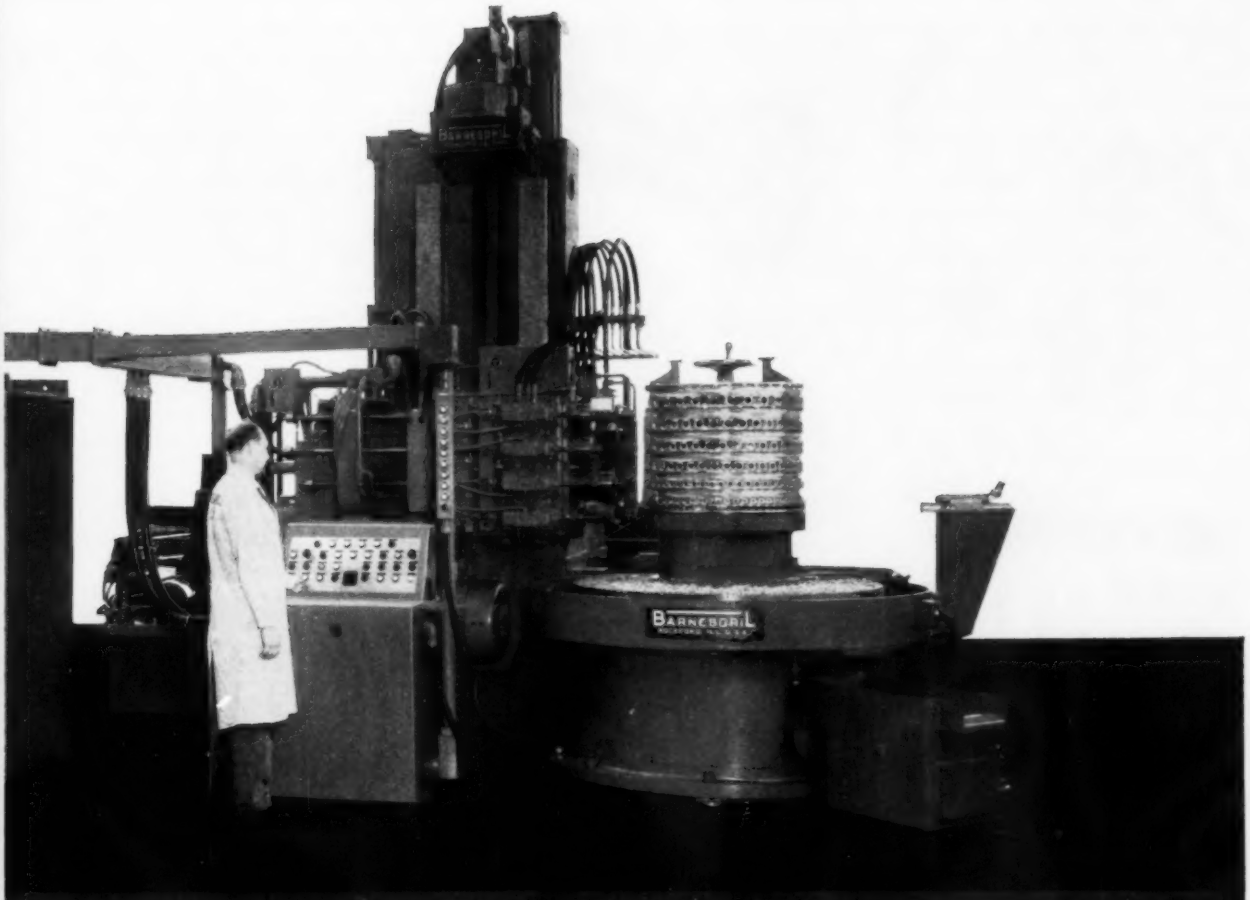
With production time now reduced to a total of 4½ hours, direct savings have also been made in elimination of fixturing, quick-changeover to different workpieces, and in precision location of all holes. In many cases inspection has been eliminated.

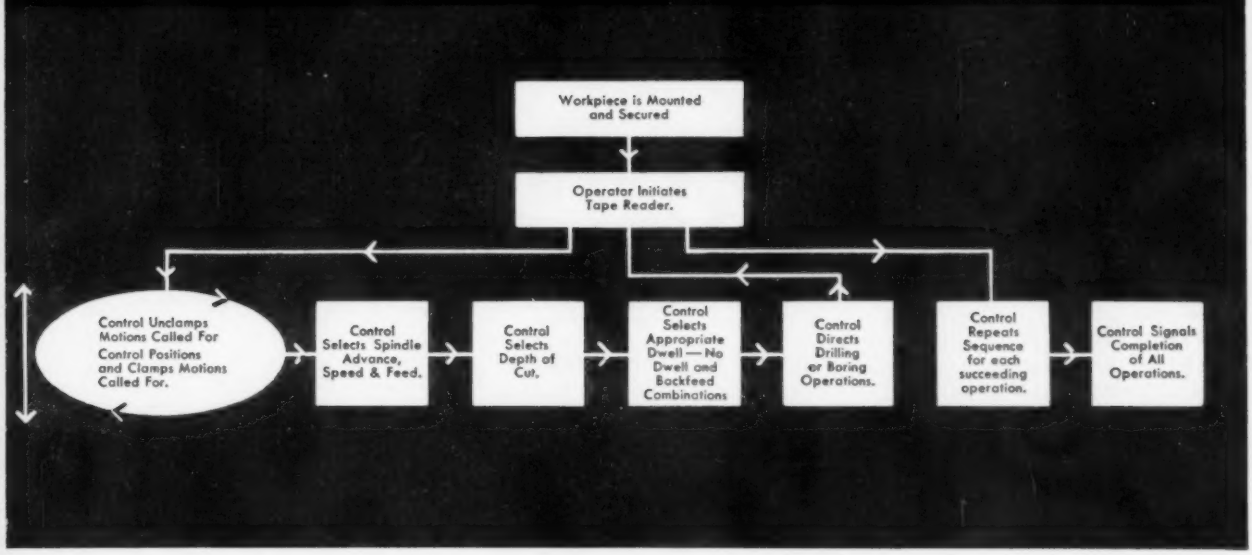
This 4-spindle machine is designed for operations on the periphery of cylindrical parts up to 50" diameter, and with a range of 40" for vertical positioning. All production data is stored in proper sequence on 8-channel punched tape, and relayed to the machine through General Electric 2-motion numerical positioning control. Machining of 248 different holes in the casing is completed automatically — 3 different hole sizes, up to 4 operations on each hole. The machine is guaranteed to hold true position within .003" and repeatability within .0002". True position tolerances may be held within closer limits through calibration of the machine. Operations include rough drilling, rough facing, finish boring, generate front face, and generate back counterbore of holes.

One of the most important features of the machine is its capacity for high accuracy and speed in selecting exact position, hole size and cutting depth. With this ability to select and control, it provides an ideal production method for efficient machining of expensive parts with complex configurations requiring high degree of accuracy. The quick-changeover feature and absence of fixturing provide high economic value for parts to be duplicated in either large or small runs. Tooling costs are held to a minimum because hole size or location changes are accomplished simply and easily through revisions in the punched tape.

your inquiries are invited!

BarnesdriL engineers invite your questions and inquiries in connection with production savings involved in program-type machining for high-output short-run parts. Send parts or drawings for estimates, or request an engineer to call and discuss these problems in your plant!



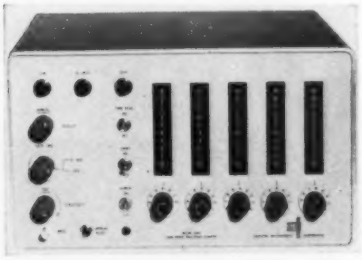

Workpiece is Mounted and Secured
Operator Initiates Tape Reader.
Control Unclamps Motions Called For Control Positions and Clamps Motions Called For.
Control Selects Spindle Advance, Speed & Feed.
Control Selects Depth of Cut.
Control Selects Appropriate Dwell — No Dwell and Backfeed Combinations
Control Directs Drilling or Boring Operations.
Control Repeats Sequence for each succeeding operation.
Control Signals Completion of All Operations.

BARNES DRILL CO.

836 CHESTNUT STREET • ROCKFORD, ILLINOIS
DETROIT OFFICE: 13121 Puritan Avenue

position indicator, or as a null indicator for tuning circuits. Unit provides visibility of conventional 2½-inch meter but requires only half as much space. Meter is accurate to ±2 per cent of full scale deflection in dc ranges. Mounted in a dustproof case, unit is supplied with plate and nuts for quick installation. It is available in fifteen ranges and types such as dc voltmeters, dc ammeters, dc milliammeters, dc microammeters, volume level indicators, and ac voltmeters. **Simpson Electric Co.**, 5200 W. Kinzie St., Chicago 44, Ill.

Circle 438 on Page 165



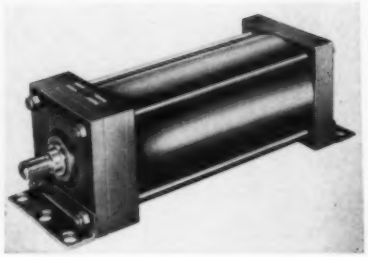
Speed/Rate Control Gage

Item 439

Device is adaptable for use as a material flow controller, a pressure or liquid flow regulating-indicator system or as a motor speed controller. Model 620 A monitors any control or limiting situation that can be stated in terms of frequency.

In operation, an unknown frequency generated by a transducer is applied at the input on the instrument. Upper and lower frequency limits are selected by setting the control knobs on the front panel. Any two frequencies falling between 1 and 40,000 cps can be selected in one cycle increments. If the unknown frequency falls below the lower preset limit, a visible red lamp marked *Low* is lighted. For input frequencies equal to or above the higher preset, another red lamp marked *High* is illuminated. If the unknown frequency is equal to or greater than the lower limit and less than the upper limit, a green lamp marked *In Limits* lights. The input frequency is displayed on decades for visual monitoring. **Computer - Measurements Corp.**, 5528 Vineland Ave., North Hollywood, Calif.

Circle 439 on Page 165

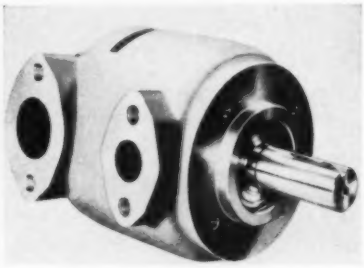


Air Or Oil Cylinder

Item 440

Line of air cylinders is designed for air pressures of 150 psi maximum and oil pressures of 500 psi maximum, has 23 different models, each in 10 bore diameters. Features include cylinder wall of precision honed brass tubing, which minimizes friction and wear, bronze floating-cushion bushings which provide smoothness of operation, and built-in check valves for smooth, instantaneous reversal. Cushioning can be provided to minimize the shock of the fast moving piston against the cylinder covers. Degree of cushioning is varied by adjusting screws. Cylinders can also be fitted for water service. **Rivett Inc.**, Brighton 35, Boston, Mass.

Circle 440 on Page 165



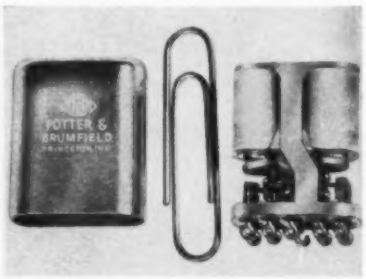
Vane Hydraulic Pump

Item 441

Line of pumps for continuous 2000 psi service is capable of supplying rated deliveries of up to 100 gpm at speeds up to 1800 rpm. Unit has either clockwise or counterclockwise shaft rotation. Shaft rotation is changed by indexing the cam ring to the dowel pin hole with the arrow indicating the desired direction of rotation. In automatic operations, pump supplies increased operating efficiency, and lower maintenance for feed circuits and index mechanisms.

Pump consists of a housing which provides an outlet connection, a bore for support of the shaft bearing and shaft assembly and a larger bore which contains the floating pumping cartridge including a front port plate, vane, rotor and cam ring assembly, and rear port plate with a shaft end support bearing. Port plates on the pump are part of the pumping cartridge. The pump can be mounted in any of four different positions. It can be face mounted or flange mounted, or mounted by means of a bracket. The inlet port can be assembled in different positions relative to the pressure post. **Denison Engineering Div., American Brake Shoe Co.**, 1160 Dublin Rd., Columbus 16, Ohio.

Circle 441 on Page 165



Magnetic Latching Relay

Item 442

Unit is capable of operating on a one watt, three millisecond pulse to either of two coils. The magnetic latch and high contact pressures hold the contacts closed under 100g shock and 30g vibrations to 2000 cps. Model SL can switch loads up to 2 amps at 30v dc resistive or 1 amp at 115v ac resistive. Unit can operate in ambient temperatures from −65 C to +125 C. Relay can be mounted by brackets or studs; is equipped with plug-in headers or hook end solder terminals for two No. 24 AWG wires. **Potter & Brumfield Inc.**, Princeton, Ind.

Circle 442 on Page 165

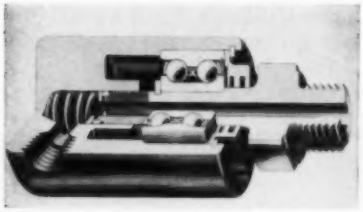
Limit Switch

Item 443

Designed especially for machine tool use, device is capable of controlling as many as four separate circuits for pilot or line duty. Actuator of the switch is adjustable in a full 360 degree sweep, on two

different planes. Switch is rated 2 hp, 230v ac; 1 hp, 115v ac; 20 amps, 125-250v ac; and pilot duty 250v ac. One of the types available is a double action model which is used for controlling switch contacts when the actuator is moved to either side of the center position. **Acro Div., Robertshaw-Fulton Controls Co.,** 2040 E. Main St., Columbus 16, Ohio.

Circle 443 on Page 165

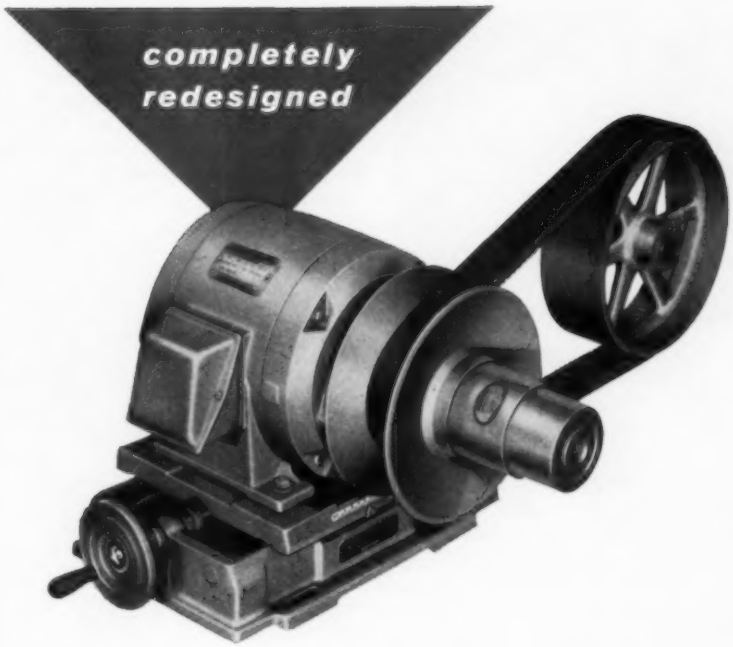


Rotating Connection

Item 444

Suitable for use on air-operated machinery and machine tools, device is constructed to transmit air, liquids, or gases from stationary sources into rotating shafts, and features lifetime lubrication. The shaft of the Rotorseal is applied directly to a tapped hole in the shaft of the machine, and rotates on sealed ball bearings within the housing. The entire unit is connected to the pressure source by a flexible hose. Protection against pressure leakage is provided by a nonmetallic sealing ring held against the shaft by spring pressure. Unit is adaptable to all types of single-passage applications at pressures to 150 psi. **Fawick Airflex Div., Fawick Corp.,** 9919 Clinton Rd., Cleveland 11, Ohio.

Circle 444 on Page 165



REEVES *Vari-Speed MOTOR PULLEY*

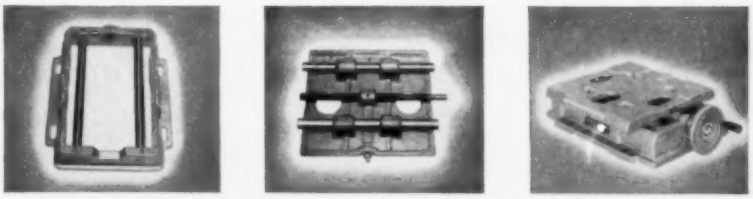
Here is variable speed control in its most simplified form . . . variable speed control with new economy.

Disc assemblies have just three main parts: two smooth-face, cone-shaped discs; and the belt tension spring. There are no other wearing parts to give maintenance trouble. Compact disc assemblies available in nine sizes, ½ hp. through 15 hp., to fit both old and new NEMA motors.

Separately mounted countershaft assemblies are available. For complete information on sizes and available controls, write for Bulletin AN36-V582.

Split section view of sliding disc shows how REEVES "close grooving" maintains film of lubricant between hub length of fixed disc and bore of sliding disc. One lubrication point services entire disc assembly.

New precision bases Four compact sizes to accommodate old and new NEMA motors in ½ through 15 hp. Sturdy bases are specially manufactured to assure positive, easy adjustment and accurate speed control.



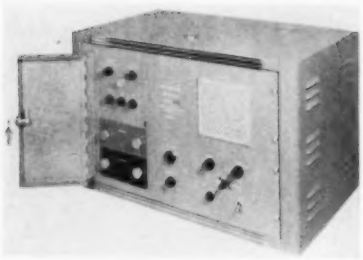
Base and motor slide rods manufactured for precision fit and true alignment. Fully-lubricated shifting screw and precision features provide easy shifting.

REEVES PULLEY COMPANY

Division of **RELIANCE** ELECTRIC AND ENGINEERING CO.

Columbus, Indiana

Circle 705 on Page 165



Testing Bridge

Item 445

Instrument is an automatic self stepping comparison type bridge which can sequentially test up to a total of 99 circuits for continuity and resistance tolerance. It can detect errors in wiring, defective components, or improper installation of components. Normal rate of testing is one circuit per second. If the circuit is not accepted during this interval, a five second delay circuit is activated to permit stabilization of circuits of long time constants. The test is then repeated. If a circuit is not accepted by the end of the 5-second interval, audible and visible alarms are actuated. Sequential action of the bridge stops at the rejected circuit to allow operator to note circuit number.

Bridge range for Model 1020 is from 200 ohms to 2.0 megohms to an accuracy of 10 per cent of the selected tolerance figure. It is rated for 110 to 125 v, 60 cps, single phase. **Communication Measurements Laboratory Inc.**, 350 Leland Ave., Plainfield, N. J.

Circle 445 on Page 165

Ball Bearing Screw

Item 446

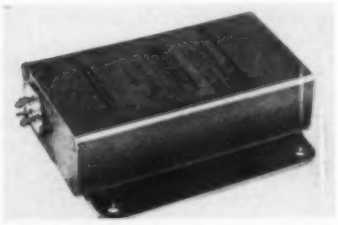
Device has a 3/16 inch ball circle diameter, is suitable for electronic controls, telemetering systems, automatic switching devices, and electronic machinery controls. It can operate at temperatures as low as −65 F, is capable of positioning components to within 0.0005 inch for each inch of travel. **Saginaw Steering Gear Div., General Motors Corp.**, Saginaw, Mich.

Circle 446 on Page 165

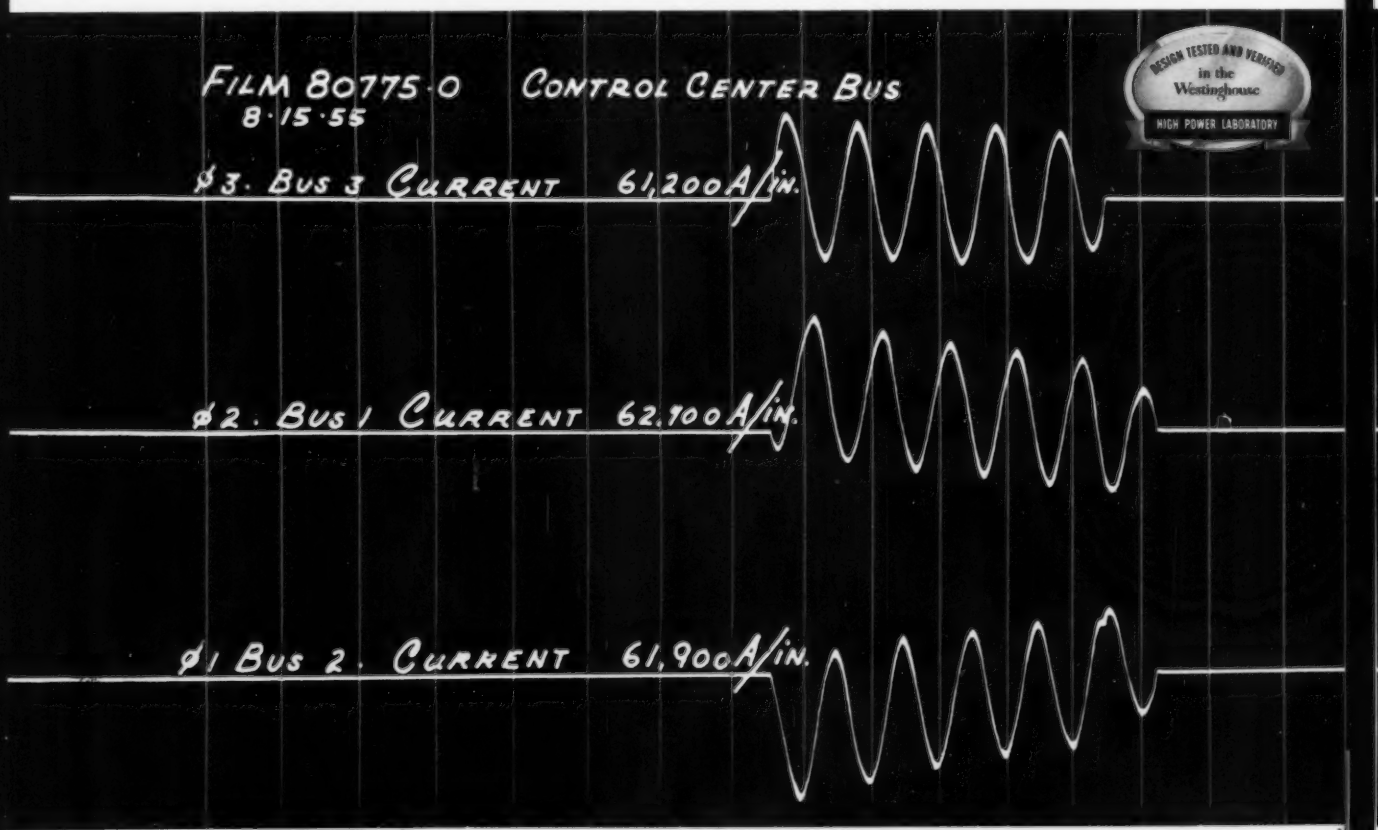
Repeat Cycle Timer

Item 447

Subminiature timer is suitable for use in systems where space is limited. Cycling times from 5 seconds to 25 minutes can be supplied. Timing accuracy is determined by the type of motor used and the environmental conditions encountered. Switch setting is in accordance with the application requirements in each case. Up to 10 switches can



be incorporated in one timer. The shortest pulse that can be obtained is 6 per cent of the over-all cycle,


FILM 80775-0
8-15-55
CONTROL CENTER BUS
ϕ3. BUS 3 CURRENT 61,200A/IN.
ϕ2. BUS 1 CURRENT 62,100A/IN.
ϕ1 BUS 2. CURRENT 61,900A/IN.
DESIGN TESTED AND VERIFIED in the Westinghouse HIGH POWER LABORATORY

and two or more switches can be set to throw simultaneously within 2 per cent of the over-all cycle time.

Switch ratings are 5 amps, 115/250 v ac and 30 v dc resistive; or 2½ amps, 30 v dc inductive. Where higher currents must be controlled, the unit can be used to operate power relays rated for the required current capacity. **A. W. Haydon Co.**, Waterbury, Conn.

Circle 447 on Page 165

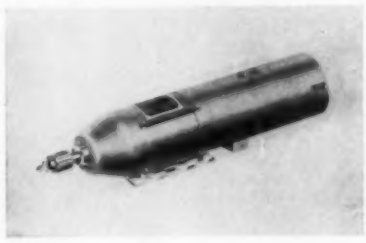
Rotary Switch

Item 448

Device is a rotary electronic switch that provides precise synchronization of mechanical motion with control of electrical circuits. Applications include one as the key control units in a sorting system; switch automatically inspects sheet material moving at 600 fpm. Geared to the shear drive, the switch generates signals which define when future cut lines pass under the inspection station. A sheet selector memory circuit determines which uncut sheet has a defect, independent of where the defect is within the sheet. A signal is then written into a synchronous memory unit which provides the delay time for the remote rejection of the sheet containing the defect, regardless of all variations in line speed. The device produces a signal at the proper time to activate the reject solenoid and to reject only defective sheets.

The light beam between an incandescent lamp and a phototransistor is normally blocked by a shutter disc mounted on the input shaft. An opening in the disc allows the phototransistor to be illuminated for a precise length of time at a precise position of the input shaft. Repeatability of synchronization is better than 0.1 degree. Resolution is also better than 0.1 degree, which means that a discrete output signal pulse can be obtained for increments of input shaft rotation as low as 0.1 degree. Unit is rated for 115 v, 60 cycles. **Automation Inc.**, 212 Worcester St., Wellesley Hills 82, Mass.

Circle 448 on Page 165



Drill Head

Item 449

Adaptable to multiple drilling and reaming operations, drill head is suitable for automatic or semiautomatic use. Unit can be used for end or hollow milling, tube flaring, tube facing, chamfering, deburring and boring and has accurate depth control. Speed is 245 to 8640 rpm. Drill unit is rated for 220-440 v, 3 phase, 60 cycle, ¼ to 7.5 hp. It is available in a 6 inch frame with 2½ inch stroke or 8 inch frame with 3½

Westinghouse CONTROL CENTER design tested at 25,000 amperes to insure safety for personnel and equipment

At the Westinghouse High Power Laboratory, the new Westinghouse Control Center design has been thoroughly tested under maximum fault conditions with no damage to equipment . . . conclusively proving it industry's safest control center.

With complete interchangeability between 9⅓-and 14-inch modular units, simplified installation and increased safety, Westinghouse Control Centers make possible the most compact, economical, centralized control systems.

For complete information on the Westinghouse Control Center, call your Westinghouse sales engineer, or write Westinghouse Electric Corporation, P.O. Box 868, 3 Gateway Center, Pittsburgh 30, Pa.

J-22102

POWER-UP starts with CONTROL

Circle 706 on Page 165

YOU CAN BE SURE...IF IT'S Westinghouse

inch stroke. **Bedford Gear and Machine Products Inc.**, 550 Krick Rd., Bedford, Ohio.

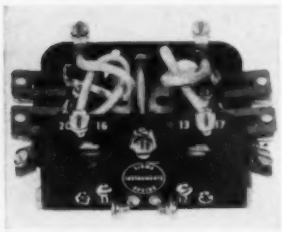
Circle 449 on Page 165

Load Control

Item 450

Relay is designed for operation in ac circuits to detect a loss of load, is suitable on grinding machines, or wherever the motor is normally loaded to at least 30 per cent of rating. In the event of tube failure or relay coil burn out, Model MEK-2128 will become de-energized in the same manner that would occur if the load had fallen below the preset level. **Machinery Electrification Inc.**, 56 Hudson St., Northboro, Mass.

Circle 450 on Page 165



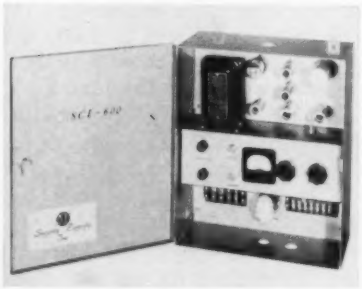
Latching Power Relay

Item 451

Applicable on machine control panels and battery energized control systems, relay is designed to switch one to two kilowatt loads in response to momentary ¼ and ½ watt signals. Constructed with a permanent magnet latch, device provides a good resistance to shock and vibration. Unit has four separate contact circuits, is available in two models. The single coil, two-position, magnetic bias, Model 61Y is normally closed. A signal of given polarity and magnitude transfers it to the opposite position, and removal of the signal or a change in polarity returns it to the normal position.

Model 61Z is a single or dual coil, two-position, magnetic latch-in. It switches as a result of a momentary coil signal of given polarity. The armature remains magnetically latched until a signal of opposite polarity returns it to the original position. Relays are rated 20 amp at 28 v dc or 120 v ac, with standard sensitivities of 225 or 450 milliwatts. Minimum life is 100,000 operations when operated not more than once per second. **Sigma Instruments Inc.**, 48 Pearl St., South Braintree 85, Mass.

Circle 451 on Page 165

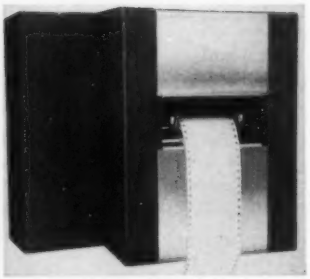


Checking Control

Item 452

Device is capable of checking the size of an object, the thickness, checking for a coating, or checking deviation between two points, without physical contact with the object. When checking for size and thickness, the object being checked is brought opposite the sensing element in a controlled position. The unit will give one signal for undersized parts, another signal for oversizes. Increases or decreases in thickness are indicated on the control. Model SCI 600 can also indicate when two thicknesses are present. When the coating has been applied to a nonconductive material, the sensing unit functions by recognizing that the dielectric constant is changed by the addition of the coating. Absence of proper coating or too much coating is also recognized. A stationary sensing element is used to indicate when a rotating part, wheel, or mechanism is out of alignment or adjustment by as little as ±0.0001-inch. **Security Controls Inc.**, 503 Franklin St., Buffalo 2, N. Y.

Circle 452 on Page 165

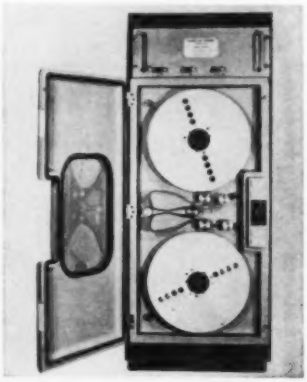


Digital Printer

Item 453

Instrument can print more than 400 digits or characters per second, is applicable to data producing sources. Model 3260 can be supplied with up to 40 columns of numeric or alphanumeric characters; is capable of printing at speeds of 20 lines per second for alpha-numerical applications. Unit is suitable for desk or rack mounting. A selection of up to 63 characters is available including alphabetical, numerical and special symbols in any desired combination. **Potter Instrument Co. Inc.**, Sunnyside Blvd., Plainview, L. I., N. Y.

Circle 453 on Page 165



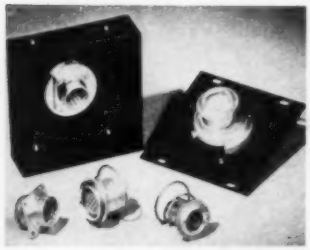
Magnetic Tape Transport

Item 454

Device provides a means of driving recording tape, is adaptable for use with numerically controlled machines. Mechanism is mounted on a hinged frame, giving access to the rear of the unit without electrical disconnection. Tape motion, tape threading, and footing indication are visible from a window. Model TA-1085 is a 14 channel magnetic tape transport with push-buttons which illuminate and indicate the mode of operation such as

Record, Playback, Fast Forward, Stop and *Fast Rewind*. The push-buttons actuate relays which can also be remotely controlled to obtain the different modes of operation. An optional attachment is a visual footage counter with accuracy to ±20 feet over the entire length of the tape. **Telectro Industries Corp.**, 35-16 37th St., Long Island City 1, N. Y.

Circle 454 on Page 165

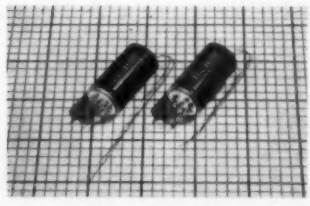


Rack & Panel Plugs

Item 455

Plugs are designed to mate without guide pins or stop-pins; for use in drawer installations, or wherever connections are inaccessible. Model DM6502 plugs mate with receptacles to provide self-aligning connectors which are environmentally sealed, vibration dampened, and unaffected by pressure variations. They mate with Model DM9606 square flange receptacles in 7, 19, 37, and 61-pin arrangements, and with Model DM5600 miniature hermetic receptacles in 7, 19, and 37-pin arrangements. **Deutsch Co.**, 7000 Avalon Blvd., Los Angeles 3, Calif.

Circle 455 on Page 165



Low Noise Choppers

Item 456

Device has noise levels below 10 mu v in low-impedance circuits. These noise levels are for wide-band noise extending from a few cps to 40 kc and measured by a thermocouple voltmeter. Contacts are rated for operation in dry and nearly dry circuits, can withstand surges

Is the Answer
to your production problem

2nd Edition of

LOGAN'S FAMOUS KEY BOOK

Often a problem that we regard as "strictly our own" has already been solved by others under similar conditions. Sometimes it's even common. That's why it pays to know what others are doing.

Perhaps the new Logan Key Book will help you iron out materials handling wrinkles adding unnecessary time and labor to production costs. Logan is happy to share its experience with you in the form of this generously illustrated booklet of authentic case histories—24 in all with 50 actual installation views.

Why don't you write for your copy today?

LOGAN CO., 218 CABEL ST., LOUISVILLE 6, KY.

Logan Conveyors

Circle 707 on Page 165

as high as 2 ma at 100 v into resistive loads. Drive is rated at 400 ±20 cps for Model 2300 (left), or 60 ±6 cps for Model 2400 (right) at 6.3 ±0.6 v rms. Normal operating temperature range is −65 C to +100 C. **Cambridge Div., Airpax Products Co.**, Cambridge, Md.

Circle 456 on Page 165

Temperature Control

Item 457

Model B95 is designed for use in hazardous locations where explosive vapors or gases are present. Thermal system consists of a bellows contained in a bellows housing. The bellows is filled with a temperature sensitive liquid which expands or contracts with heating or cooling, activating a snap-action single-pole switch at the desired preset temperature point.

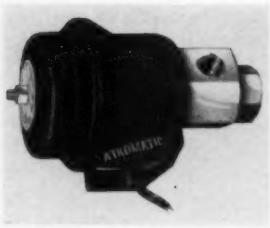
Temperature settings are made by rotating a single turn knob and pointer against a calibrated dial. Unit is available with adjustable ranges between zero and 425 F, with *On-Off* differentials of approximately 3 F and 8 F for circulating air; 1 F and 2.5 F for circulating liquid; 6 F and 15 F for gravity air. Control is offered in three switches; normally open, normally closed, or double throw with no neutral position. **United Electric Controls Co.**, 85 School St., Watertown, Mass.

Circle 457 on Page 165

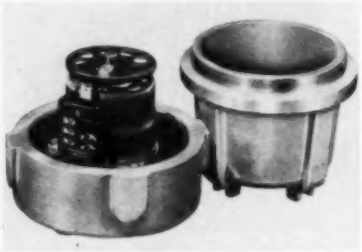
Solenoid Valve

Item 458

Designed to control high pressure corrosive gases and fluids, solenoid valve is rated to 6000 psi. Explosion-proof housing can be supplied. For leak-proof operation with gases such as hydrogen and nitrogen, a bubble-tight construction is furnished; to assure tight closings, Teflon or nylon seats are offered. Valve is available in ⅛, ¼, ⅜, and ½-inch pipe sizes. **Atkomatic Valve Co. Inc.**, 545 W. Abbott St., Indianapolis 25, Ind.



Circle 458 on Page 165

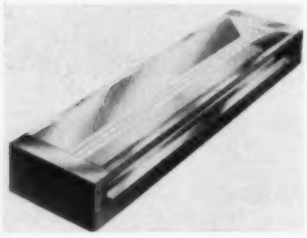


Variable Autoformer

Item 459

Explosion-proof unit is designed for panel mounting in hazardous areas where power line voltage control is required. Model 6240 (shown) has a power input of 120 w, 60 cps and an output of zero to 140 v, 7.5 amps, 1 kva maximum. It is supplied with a Superior Electric Co. Type 116 Powerstat, but other controls such as rheostats and potentiometers are available. Two smaller models with lower power ratings are also offered. **I-L-S Instrument Corp.**, 4526 W. 160th St., Cleveland 11, Ohio.

Circle 459 on Page 165



Infrared Oven Section

Item 460

Suitable for industrial finishing operations, infrared oven section

ANY SPRAY VOLUME — EITHER SIDE OF NOZZLE
ANY SPRAY PATTERN
ANY STROKE LENGTH
ANY NUMBER OF NOZZLES (1 TO 5)
SPRAY ANY DIRECTION
ANY NOZZLE POSITION
ANY STROKE SPEED — EITHER DIRECTION
SPRAYS THROUGH ANY PORTION OR PORTIONS OF OUTWARD AND RETURN STROKES

New Automatic Positioning and Control of Reciprocal Spraying

Send Today for NEW BULLETIN! No Obligation!

Ends sloppy swabbing, drenching, splashing, sloshing

For high-speed, automatic spray-coating or spray-lubricating of parts, products, or production-machine tooling surfaces — with any sprayable lubricants, chemicals, or compounds get full details on MOTO-SPRAY. Moto-Spray's unlimited versatility for automation warrants your prompt inquiry on almost any need of this kind. New bulletin 101 tells the story. Call or write today.

RENITE COMPANY
Lubrication Engineers
COLUMBUS 1, OHIO
P. O. BOX 8065

Circle 708 on Page 165

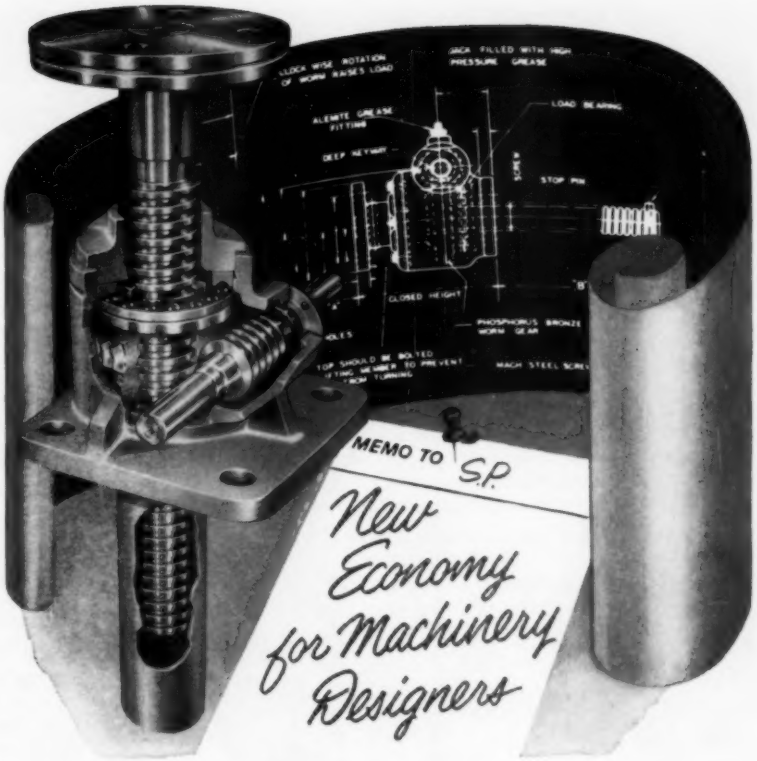
can be equipped with metal rods, quartz lamps, or quartz tubes. Two types of reflectors are available; specular gold and aluminized steel. For maximum efficiency from any source used, the reflectors are optically designed to distribute an even pattern of radiant heat over the entire product. The socket design makes it possible to load or change source units from the front of the oven. Terminal wires can be inserted into the sockets and securely fastened from the front. The socket will accommodate one, two, or three heat sources. Bolt-type construction allows rapid changeover to meet varying production requirements, and the open-end design allows the addition of more sections when production requirements call for greater finishing capacity. **Fostoria Pressed Steel Corp.**, Fostoria, Ohio.

Circle 460 on Page 165

Subminiature Counter

Item 461

Transistorized decade counter has a maximum operational frequency of 1 megacycle. Decade consists of four binary circuits separately constructed in an individual cartridge assembly, each independently usable as a flip-flop or binary stage. Each binary module is replaceable in the decade. Model M6744 can operate in a temperature range of −40 C to +55 C. Decade output is 6 v amplitude with 0.1 microsecond rise time. A packaged circuitry is available which can be used in conjunction with the decade. It includes a plug-in trigger circuit with an input amplitude sensitivity of from 0.5 to 1.5 v rms, a prepackaged decimal light indicating strip and matrix for remote indication service, and a plug-in commutating circuit which permits presetting of the decade and is useful for sequential trigger, switch-



NOW, A STANDARD LINE OF DUFF-NORTON WORM GEAR JACKS

The economies of standardized production now can be realized by machinery designers who use Duff-Norton worm gear jacks for accurate positioning of loads weighing as much as several hundred tons. After 25 years of experience and hundreds of custom designs, Duff-Norton engineers have produced a standard line of eight jacks ranging from 2 to 100 tons in capacity which will meet almost any requirements. When jacks are used in an arrangement, added economy can be realized in raising unevenly distributed loads, since all models now have a uniform raise which permits jacks of varying capacities to operate in unison.

Worm gear jacks are purely mechanical devices, and they can hold heavy loads in position indefinitely without any creep. Functioning as components of machinery or equipment, they can raise or lower loads, apply pressure or resist impact. Worm gear jacks can be furnished with raises up to 24 inches, and they will provide exactly the same raise for years without adjustment.

Thousands of these jacks are in use on feeding tables, tube mills, welding positioners, pipe cut-off and threading machines, testing equipment, aircraft jigs, loading platforms, rolling mills, conveyor lines, and numerous other types of equipment. If you have a positioning problem, write for complete information, requesting Bulletin AD-66-GG, which includes drawings and full specifications.

DUFF-NORTON COMPANY

P. O. Box 1889 • Pittsburgh 30, Pennsylvania

COFFING HOIST DIVISION • Danville, Illinois

DUFF-NORTON JACKS
Ratchet, Screw,
Hydraulic, Worm Gear

DUFF-NORTON

COFFING HOISTS
Ratchet Lever
Spur Gear, Electric

Circle 709 on Page 165

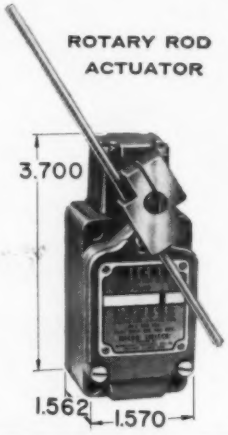
MICRO SWITCH Precision

...FIRST IN PRECISION SWITCHING

Two sound ways to

Compact "LS" Limit Switches are Available in 6 Different Actuator Designs

COIL-SPRING ACTUATOR



ROTARY ROD ACTUATOR

ROTARY ARM ACTUATOR

ROLLER PLUNGER ACTUATOR

PLUNGER (IN-LINE) ACTUATOR

ADJUSTABLE ROTARY ACTUATOR

These are small two-circuit, completely sealed limit switches. Their small size and versatility of mounting permits compact installation on all types of industrial machinery which require dependable long-life precision switch gear.

In this "LS" series there are six actuator designs. All rotary actuators are field adjustable to operate in clockwise direction, counter-clockwise, and in both directions—with operation point adjustable to any position thru 360 degrees. Their heads can be faced in any of four positions.

The ½"-N.P.T. internally tapped conduit opening is in the bottom of the housing. The replaceable basic switching unit within enclosure has No. 8 terminal screws.

COIL-SPRING ACTUATOR

Can be operated from any direction. Useful in foundry, conveyor and packaging operations.

ROTARY ROD ACTUATOR

Has extremely low force characteristics. Rod is adjustable to any length. Operating point and direction are adjustable. Excellent for use in counting and detecting applications.

ROTARY ARM ACTUATOR

The heavy duty forged aluminum arm actuator with roller is designed for cam and slide operation. Field adjustable operating point and direction. Its uses are unlimited.

ROLLER PLUNGER ACTUATOR

For slow-rise cams or slides, this actuator head can be rotated 90° for operation by cams whose approach is perpendicular to the mounting surface of the switch.

PLUNGER (IN-LINE) ACTUATOR

For use where the switch can be located so that the switch plunger motion is in line with the actuating device. Plunger has ¼ inch overtravel.

ADJUSTABLE ROTARY ACTUATOR

Roller lever arm length is adjustable to any point in a 2½ inch range. Head assembly can be positioned to any of 4 sides of switch. Actuating direction and operating point are adjustable.

For details as to electrical ratings, mechanical characteristics, adjustability, and other features on this series of limit switches, ask for Data Sheet 138 and Catalog 83 on enclosed switches.

Switches have uses unlimited

improve initial design

The New "E6" and "V6"... Easier Installation
... Better Sealing ... Improved Insulation

The new "E6" and "V6" series of small limit switches have many new and improved features over the design first introduced by MICRO SWITCH in 1939. This design is the smallest and most compact enclosed limit switch available for all industrial uses. This new series is interchangeable with the old series—same mounting holes, and same envelope (housing) dimensions.

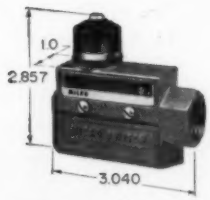
The new housing is divided into two parts with the terminal screws exposed. This saves wiring time.

The new one-piece elastomer combination insulator and seal is cemented into the bottom half of the switch assembly, replacing a separate gasket and wrap-around glass cloth insulator. This saves installation time and provides excellent insulation and sealing of the enclosure when assembled.

The new housings have heavier walls yet envelope (housing) dimensions are the same as the old design. Hexagonal conduit hub facilitates connecting of conduit.

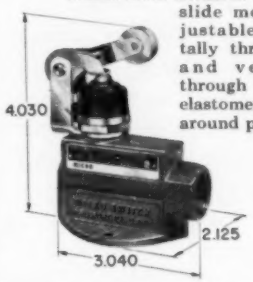
Six different actuator types are available. All six are available in either side mounting (E6) or bottom mounting (V6) designs.

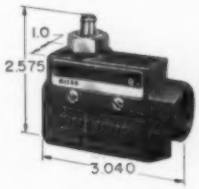
Ask for Data Sheet 145 and Catalog 83 for data on line of enclosed switches.



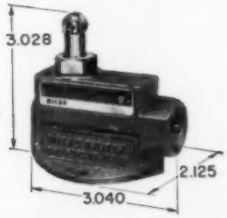
Actuator for straight, in-line operating motion with controlled overtravel. Elastomer seal boot around actuator protects against dirt and moisture.

Roller lever actuator for cam or slide motion, adjustable horizontally through 360° and vertically through 225°. Has elastomer seal boot around plunger.

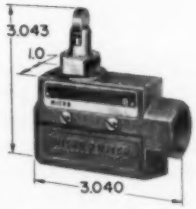




Plunger actuator for straight, in-line operating motion with controlled overtravel.

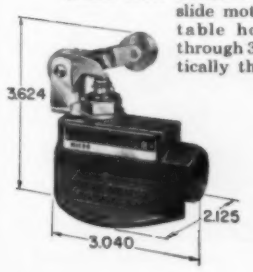


Roller plunger actuator for slow-rise cam or slide motion with controlled overtravel. Roller in line with case.



Roller plunger actuator for cam or slide motion with controlled overtravel. Roller at 90° angle to case.

Roller lever actuator for cam or slide motion, adjustable horizontally through 360° and vertically through 225°.



MICRO SWITCH . . . Freeport, Illinois
A Division of Honeywell

The two-word name MICRO SWITCH is NOT a generic term. It is the name of a division of Honeywell.

Honeywell
MICRO SWITCH PRECISION SWITCHES

Circle 710 on Page 165

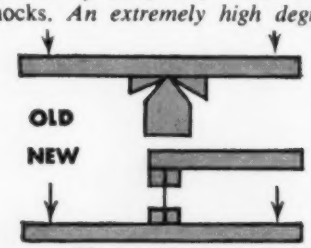
New Valentine Division Plant of A. P. Green Fire Brick Company

Heavy, sticky, lumpy materials batched with high accuracy

Heavy duty batching system requiring little headroom is also capable of handling flooding powders

DO YOU HAVE A BATCHING PROBLEM more difficult than accurately mixing raw clays and grogs which vary from oozy-wet one day to rock-hardness the next? Thayer solves such a rough-and-tumble problem by 1) engineering all the component feeders, hoppers, scales and their automatic controls as one unit and 2) utilizing the unchanging precision of the patented Thayer Plate Leverage System.

THIS EXCLUSIVE LEVERAGE SYSTEM outperforms all others. It is not affected by dust, dirt, vibration or shocks. *An extremely high degree of reliability is maintained* through the use of patented non-fatiguing Thayer Flexure Plates instead of vulnerable knife-edge pivots.



THAYER AUTOWEIGHTION is accepted as the most reliable system of batching or continuous formulating. Thayer Scales have performed millions of weighing operations without maintenance, loss of accuracy or diminished sensitivity.

The world's most reliable leverage system is also available in Thayer filling and checkweighing scales.

THE Thayer SCALE

*THE THAYER SYSTEM OF PROCESS CONTROL BY WEIGHT

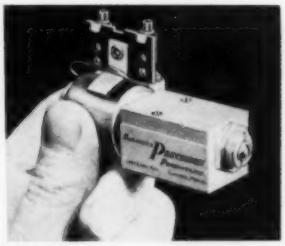
AUTOWEIGHTION

THE THAYER SCALE CORP., 5 Thayer Park, Pembroke, Mass.

Circle 711 on Page 165

ing, and gating operations, or other control functions. **Walkirt Co.**, 141 W. Hazel St., Inglewood 3, Calif.

Circle 461 on Page 165

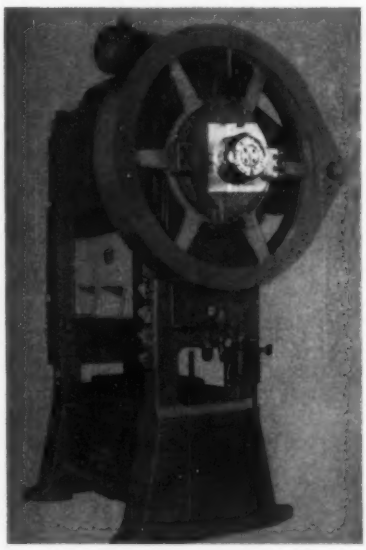


High Pressure Valve

Item 462

Designed for pilot operation of larger valves, device can also be used as a direct active *On-Off* valve in small hydraulic systems, and for high pressure lubricating systems. When two or more are mounted on a subplate, they can be used as a three or four-way valve. Valve is constructed for 3000 psi, delivers 17 cu in. per min at 100 psi pressure drop. It can handle hydraulic oils, kerosine, or lubricating oils. Unit is rated 6 to 48 v dc and 110 v ac. **Sarasota Precision Products Inc.**, 1312 N. Lime Ave., Sarasota, Fla.

Circle 462 on Page 165



Tonnage Limiter

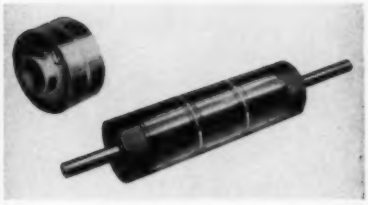
Item 463

Electromagnetic torque limiting device protects presses against overloads through the press cycle. Limiter can be installed on the crank-

shaft, or on the backshaft of any mechanical press. It follows the actual press tonnage capacity throughout the working portion of the stroke. When work tonnage exceeds the preset limit, device disengages the crankshaft from the flywheel and drive.

Limiter is effective at any point in the press stroke. If required, it can be set to disengage at tonnages under the press capacity. Low capacity disengagement is accomplished by decreasing the direct current flowing through electromagnetic coils. The coils create the magnetic force that keeps the coupling engaged between the main gear and the crankshaft. **E. W. Bliss Co.**, 1375 Raff Rd. S.W., Canton 10, Ohio.

Circle 463 on Page 165



Magnetic Flat-Face Rolls

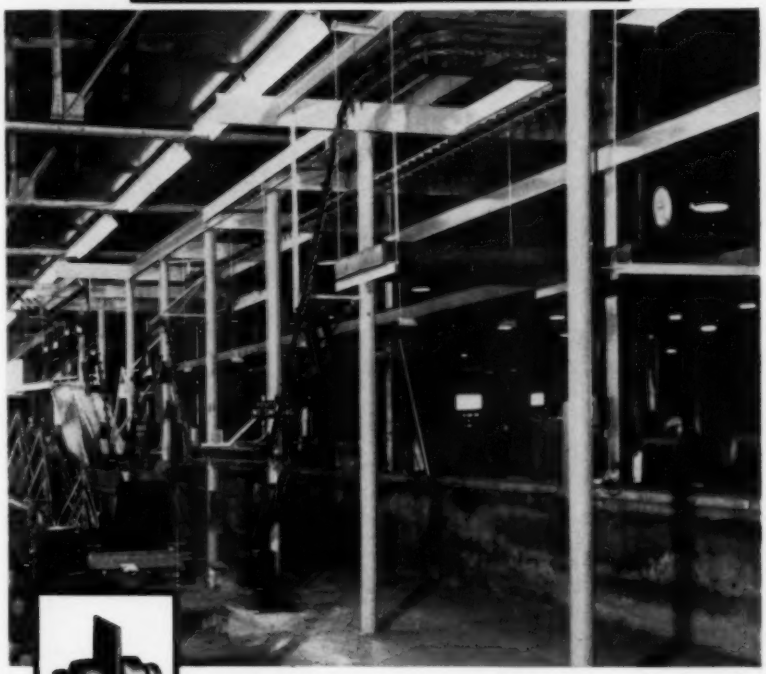
Item 464

Line of nonelectric magnetic flat-face rolls can be used as head pulleys or tail pulleys on conveyor systems for holding, controlling or elevating ferrous parts, receptacles, boxed metal pieces, rods, bars, pipes, and steel sheets. Magnetic rolls can automatically transfer parts from one belt to another, reorient the individual parts or containers, and control the carry-over of parts or boxed metal items at the top of inclined conveyors.

When installed as head or tail pulley, the unit can automatically lift parts from a lower conveyor line, turn them over, and carry them on a line moving at right angles to the first; or when installed as a tail pulley on an upper line, it can lift parts from a lower line, turn them over, and carry them on in the original direction for inspection or painting, or it can lift steel receptacles from a lower line, carry them up and around the return of the upper line, reversing their direction and turning them right-side

A NEW LIGHT-DUTY TROLLEY CONVEYER . . . ENGINEERED AND STANDARDIZED BY

MATHEWS



A #232 Trolley Conveyer Applied for painting, drying and storage of miscellaneous parts.

This light-duty Trolley Conveyer has several features which make it a leader in the field of overhead conveying. It is comparatively easy to install, with hanger-rod and angle hanger supports available to meet any supporting requirements. Standard turns, vertical bends, and takeup assemblies are made in sizes and types to fit even the most difficult layout.

The drive units have a wide range of capacities and horsepowers, with conveyer speeds ranging from one to fifty feet per minute.

The #232 wheel was specifically designed for trolley conveyer service **and is an outstanding performer. This equipment is priced reasonably and is available from stock, being assembled from standard parts throughout.**

Write for Bulletin T-58 today.

MATHEWS CONVEYER COMPANY

GENERAL OFFICES . . . . . ELLWOOD CITY, PENNSYLVANIA
PACIFIC COAST DIV. . . . MATHEWS CONVEYER COMPANY WEST COAST, SAN CARLOS, CALIFORNIA
CANADIAN DIVISION . MATHEWS CONVEYER COMPANY, LTD., PORT HOPE, ONTARIO.

MATHEWS

Over Fifty Years of Leadership in Mechanized Handling

Circle 712 on Page 165

Series 101A
150 psi Air
1500 psi Hydraulic
Meet JIC Standards
Fit where
others won't!

O-M Cylinders give power new dimensions in close quarters

Compared with cylinders of conventional design, having the same size bore, and activated by the same operating pressure, O-M's original Internal Key-type Cylinders develop more power in ⅓ less space on both air and hydraulic circuits.

These compact, powerful components, that fit where others won't, are ruggedly constructed to stand up under protracted service within a wide range of operating pressures. The O-M Internal Locking Key simplifies disassembly, inspection, and service with no alignment problems in reassembly. Besides, the ports can be oriented to any position.

The unique O-M design also assures maximum versatility. By using a majority of standard parts, you get the advantage of "special" cylinders designed to do your job better at a very nominal cost over standard cylinders. These and other engineering advantages and economies of O-M Internal Key-type Cylinders suggest uses in a wide variety of original equipment.

O-M Internal Key-type Air and Hydraulic Cylinders are available in a complete range of sizes (1½" to 8" bores) with standard or heavy-duty rods. Completely interchangeable parts and mounts. Immediate delivery on many sizes.

Mail Coupon TODAY *for Bulletins 101A (O-M Internal Key-type Air and Hydraulic Cylinders), and 105 (O-M Series T-H Heavy-duty Hydraulic Cylinders).*

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☐ Have representative call

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Name_____ Position_____

Company_____

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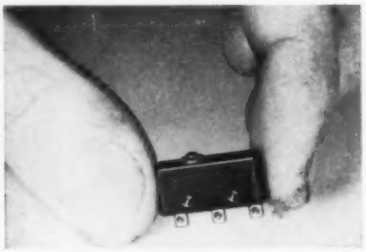
City_____ Zone_____ State_____

Circle 713 on Page 165

up in the same operation. Device is adaptable to a wide range of belt sizes, types of material, or operational requirements and needs no electrical connections to operate. **Eriez Mfg. Co.**, Erie, Pa.

Circle 464 on Page 165



Subminiature Switch

Item 465

Model E4-134 can be used individually or in multiple unit bank assemblies; is applicable in places requiring electrical control in a limited space. It is a single-throw double-pole switch, has 1,000,000-operation mechanical life at 0.005 overtravel. Switch is rated at 0.5 amps, 125 to 250 v ac; 2.5 amps, 30 v dc, resistive; 4 amps, 30 v dc inductive; with an ambient temperature range of −65 to −250 F. Unit is available with turret or standard solder terminals and with a wide range of actuators for manual, in-line, cam, or slide applications. **Electro-Snap Switch & Mfg. Co.**, 4218 W. Lake St., Chicago 24, Ill.

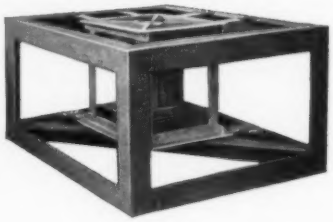
Circle 465 on Page 165

Precision Ball Bearings

Item 466

Miniature units feature a maximum complement of balls, with continuous shoulders on both sides of deep groove raceways uninterrupted by ball loading notches, and a one-piece precision retainer of machined phenolic. They are applicable on numerous instruments and electromechanical devices where limited space is a factor. The maximum complement of balls is

eccentric loading, side thrusts, pile-ups won't affect the accuracy of THE W-C UNI-FORCE PLATFORM SCALE



No matter where or how the load falls, the Uni-Force Scale will deliver a true measurement of weight. Reason for this remarkable performance is the W-C flexural frame arrangement which resolves platform thrusts into a single component of force applied to the load transducer. Flexure mounting eliminates bearings, knife-edges, pivots and other points of concentrated wear and friction. So dependable is scale operation that W-C guarantees an accuracy of ± 0.25% of calibrated range and a reproducibility of 1 part in 2000.

The Uni-Force Platform Scale is manufactured in a wide selection of standard capacities. It is supplied as a complete, packaged unit which includes either electrical or pneumatic transmission. Because the transmitted signal can be used to actuate a number of devices, the Uni-Force Scale is readily adaptable to such automatic functions as remote indicating, recording, batching, proportioning . . . just about any weight-controlled operation.

For complete information, write for Catalog 12.

W-C

S.A. 1666

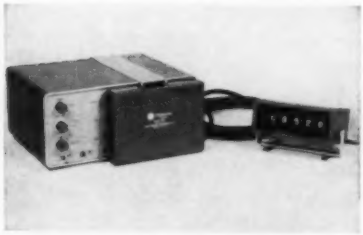
WEIGHING and Control COMPONENTS, Inc.

206-C Lincoln Ave., Hatboro, Pa.

Circle 714 on Page 165

accomplished by fracturing the outer ring. Four sizes of bearings are available with bores of ⅜-inch, ½-inch, ⅝-inch, and ¾-inch, and corresponding OD's ¼-inch greater. Width of the units is 5/32 inch. **Split Ballbearing Div., MPB Inc.**, Lebanon, N. H.

Circle 466 on Page 165

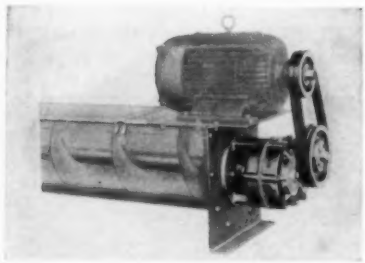


Photoelectric System

Item 467

Instrument is capable of translating a vertical decimal display directly to an in-line display. Model 1520 is attached to the front of a decade counter unit. It is powered from a 115-120 v, 50-60 cycle power line and draws approximately 0.6 w per decade. Where frequent adjustment of the counter unit is not required, the counter unit and the reader head can be located at a remote point. Optional equipment available includes multi-readouts, relay rack panel, and custom readouts. **Radio Frequency Laboratories Inc.**, Boonton, N. J.

Circle 467 on Page 165



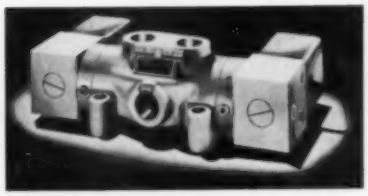
Screw Conveyor Drive

Item 468

Unit consists of a speed reducer with packing glands and driving shaft; can be mounted on a conveyor trough end. Drive uses heat-treated helical steel gear and pinions, and Timken bearings. The packing gland is adjustable from the outside, and can be inspected by sight.

A flinger seal on the shaft next to the reducer also prevents liquids or other foreign matter from reaching the reducer seals. Further protection against contamination is provided by double lip reducer seals. Screw conveyor drives are available in four sizes; each size is offered in two ratios—18 to 1 and 8 to 1. Output speeds are chosen from preselected V-belt drive tables. **Dodge Mfg. Corp.**, Mishawaka, Ind.

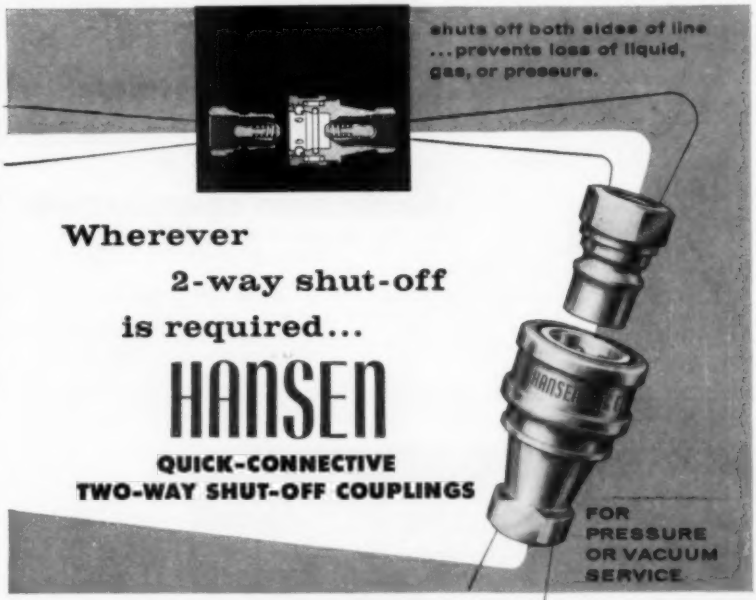
Circle 468 on Page 165



Hydraulic Valve

Item 469

Line of directional control valves is designed for hydraulic oil systems. Six models with different



To connect a Hansen Two-Way Shut-Off Coupling, you merely pull back the sleeve and push the Plug into the Socket. To disconnect, just pull back the sleeve. No tools required. When Coupling is disconnected, similar valves in Socket and Plug shut off both ends of line—practically eliminate spilling of liquid or escape of gas at instant of disconnection.

Hansen Series HK Two-Way Shut-Off Couplings for pressure or vacuum service are available with female pipe thread connections from ⅛" to 1" inclusive. All sizes are available in either brass or steel.

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Here's an always ready reference when you want information on couplings in a hurry. Lists complete range of sizes of Hansen One-Way Shut-Off, Two-Way Shut-Off, and Straight-Through Couplings—including Special Service Couplings for Steam, Oxygen, Acetylene, etc.

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Circle 715 on Page 165

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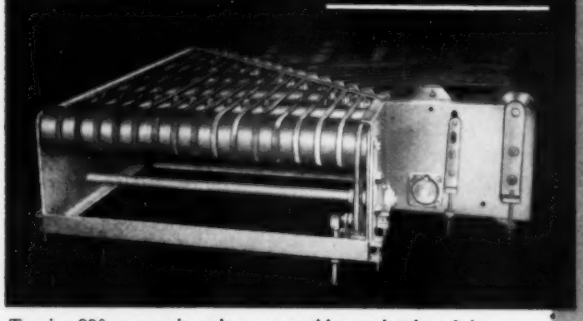
Operative to −196°C

Circle 716 on Page 165

NEW STEWART-TURN
the 90° turn that really works!

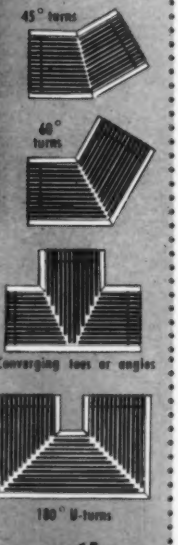


Turning 90° corners is no longer a problem or bottleneck in material handling systems. The unique Stewart-Turn moves material around corners as easily as in a straight line! No rollers to stick, tight corners to jam or deflectors to damage the material being moved. Never before has this been possible!

The Stewart-Turn is a series of narrow-faced belts, running in grooved pulleys, banked for constant contact with the material in motion. A slight differential in speed between the bank of belts produces a positive turning action, with belts spaced to carry small as well as large or long articles. Belt friction reaction to turning has been eliminated.

Stewart-Turns, as well as all Stewart-Glapat material handling equipment and conveyors, are CUSTOM DESIGNED TO YOUR JOB. If you are looking for advanced engineering thinking for your material handling or automation problems, WRITE STEWART-GLAPAT TODAY, and ask for complete details on the sensational, new Stewart-Turn!

A few other applications of versatile Stewart-Turns.



STEWART-GLAPAT Corporation
1645 Moxahala Avenue, Zanesville, Ohio

Circle 717 on Page 165

methods of operation are furnished. They include lever operated, stem operated, cam operated, oil pilot operated, air pilot operated, and oil pilot operated, solenoid controlled. Valves have interchangeable mounting dimensions, are suitable for systems up to 3000 psi. Two pipe sizes are available, ½-inch for 12 gpm flow, and ¾-inch for 18 gpm flow. **Dukes Co. Inc.**, 3999 N. 25th Ave., Schiller Park, Ill.

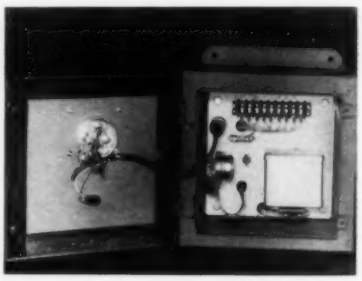
Circle 469 on Page 165

Miniature Chopper Switch

Item 470

Device is designed with a low thermal construction, is suitable in chopper stabilized dc amplifiers where thermal stability and low noise are necessary. The coil, which is interchangeable, has an electrostatic shielding from the contact assembly. It is optimized for minimum power drive and thermal dissipation at a preselected frequency within the operating frequency range of zero to 700 cps. Thermal stability is less than ±2 microvolts. Chopper mates with a standard 4-pin miniature socket. **Bristol Co.**, Waterbury 20, Conn.

Circle 470 on Page 165



Punch Press Control

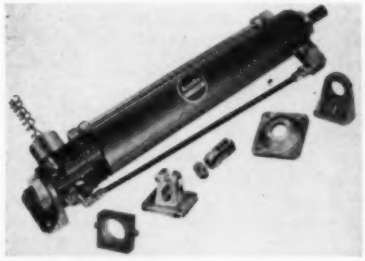
Item 471

Device is designed to reduce shut-down time on high-speed automatic and semiautomatic punch presses, and to protect against dam-

age to presses and dies. In operation, an indicating pointer is activated by a current transformer, and in response to the current, the pointer moves across the dial of a contact ammeter, displaying continuously and visibly the load on the drive motor.

A second adjustable pointer is set above the level of the current required to operate the press. If a double sheet is fed into the die, or if a piece is unusually hard or thick, the increased current drives the indicating pointer into contact with the adjustable pointer. The control action is then initiated, the press clutch is disengaged, taking all driving energy from the ram. The operator then removes the bothersome piece before damage has been done. Control is rated for 110, 220, or 440 v. Control ranges available are 1.5, 10, 20, and 100 amps. Press speeds as high as 450 strokes a minute can be handled by this control. **Tipptronic Inc.**, Dept. PP, Chagrin Falls, Ohio.

Circle 471 on Page 165



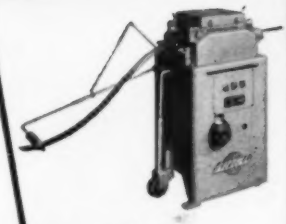
Self-Returning Cylinder

Item 472

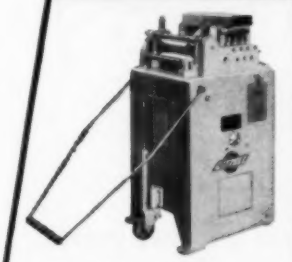
Line of cylinders is designed with the return-controlling unit as part of the cylinder head. A single actuation of the control sends the rod to full stroke and it automatically returns upon reaching the end of its stroke. The automatic-return cylinders are available for single control by electric switch or bleeder valve; with rods normally retracted or extended. The electric models, rated for 8, 110, or 220 volt operation, are offered in five bore sizes. The automatically reciprocating cylinders require only one air connection to the cylinder-valve unit and are controlled by a standard shut-off valve. **A. K. Allen Co. Inc.**, 255 E. Second St., Mineola, N. Y.

Circle 472 on Page 165

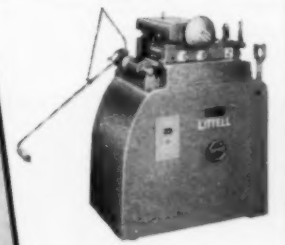
LITTELL STRAIGHTENERS



No. 208 STRAIGHTENER
For stock .010" to .040" thick and up to 8" wide. Also straightens stamped parts.



No. 308 STRAIGHTENER
For stock .018" to .065" thick and .018" to .050" thick, up to 12" wide.



No. 412-5PD STRAIGHTENER
For heavier stock from .040" to .125" thick by 12" wide.

FOR
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COIL STOCK STRAIGHTENING AT ANY SPEED YOUR PRESS REQUIRES

STANDARD LITTELL STRAIGHTENERS with Variable Speed Drive straighten stock at any speed from 10 to 60 feet per minute. Proper slack in straightened stock between straightener rolls and press is automatically maintained by the Arm Control's up and down action which starts and stops the straightener motor.

ELECTRIC CLUTCH and BRAKE LITTELL STRAIGHTENERS provide for high speed intermittent straightening action with no motor stop. Ideal for hump feeding.

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Circle 718 on Page 165

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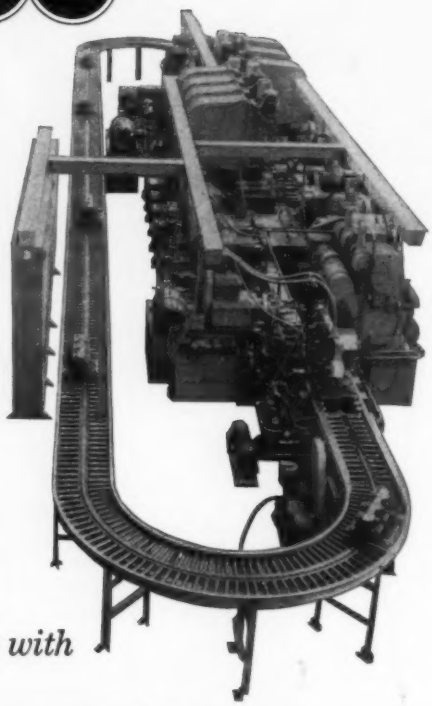

Buschman conveyor, integrated into this 23-station machine built by Avey Drilling for leading automotive parts manufacturer, assures continuing machining, checking, gauging and semi-assembly of 360 Automotive hydraulic steering pump bodies per hour.

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AUTOMATION

problem forum

Readers with problems concerning systems, equipment or components for automated operations are invited to outline them to: The Editor, AUTOMATION, Penton Bldg., Cleveland 13, Ohio. Solution suggestions should refer to case number and title of the problem involved.

Case 1505-P
Press Feeding

. . . We would like an automatic feed to transfer 0.010-inch thick steel and copper sheets 30 inches long by 12 inches wide into a punch press. . .

Chief Industrial Engineer

• • •

Case 1496-P
Testing Brazed Conductors

. . . We are trying to find a nondestructive method to test for cracks and flaws in brazed joints between armature conductors and commutator segments in direct current armature risers. Two conductors, one on top of the other, are resistance brazed to the top of a commutator segment to form a riser. Cracks sometimes start at the brazed joints and extend through a conductor. The armature is assembled before the joints are brazed. It is possible to get at the top and end of a brazed riser. Also there is a space between the sides of adjacent risers which is 3/16 inch wide at the top and 3/32 inch wide at the bottom. There are 41 risers to an armature, and it will be necessary to check each riser individually. Any information or leads will be greatly appreciated. . .

Supervisor
Quality Control Equipment Design

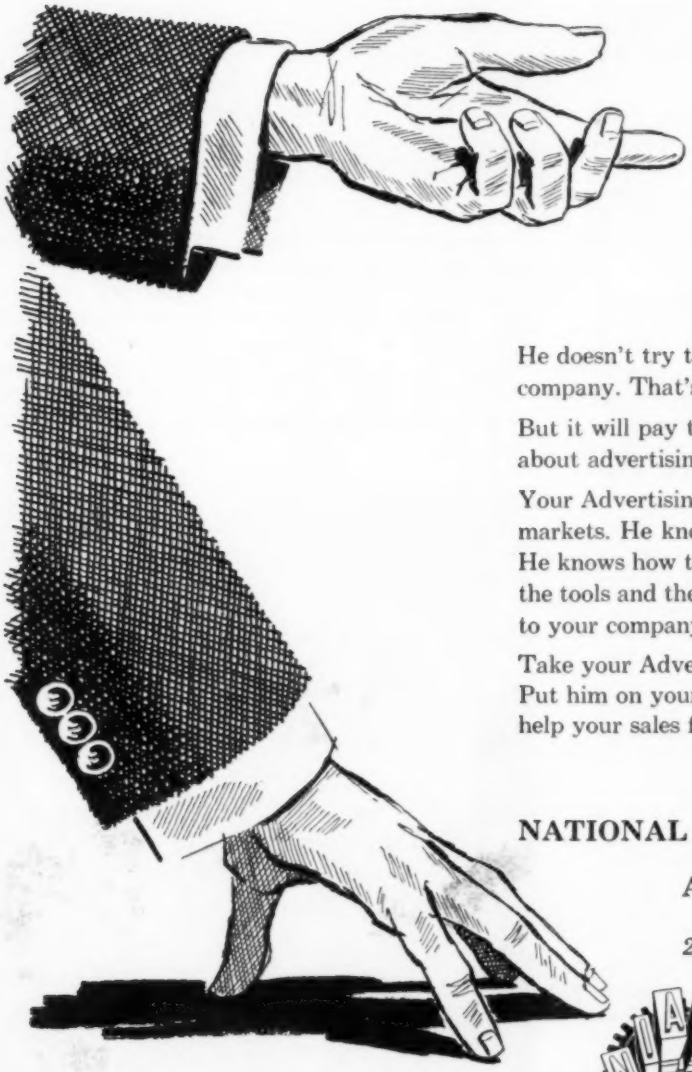
• • •

Case 1504-P
Carton Counting

. . . We are producers and packagers of detergents in folding cartons. As the filled cartons move along on a conveyorized packing table, the packers must visually count off groups of eight to collate and pack the cartons in shipping cases. We would like to buy or make a simple device that could be actuated by the moving cartons themselves, which would count eight cartons and push the eighth carton slightly out of line from the group. We would appreciate any advice or help. . .

Process Superintendent

Does your Board of Directors listen to this man?



He doesn't try to tell your Directors how to run the company. That's their job, and he respects it.

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Your Advertising Manager is a man who knows markets. He knows the science of "mechanized selling." He knows how to help turn sales goals into sales. He has the tools and the know-how to make major contributions to your company's progress and profit.

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AUTOMATION abstracts

AUTOMATIC QUALITY CONTROL

By W. S. TANDLER
President, Warner & Swasey Research Corp.
New York, N. Y.

FROM a managerial point of view, automation of quality control is a very important subject. If it can be done it solves a number of serious problems. I don't have to explain what savings can be made in production by having persistently good quality, nor do I have to explain what advantages good quality has as far as sales are concerned.

There is another aspect which is of interest, and that is the quality control of the product in development. In research and development, quality control has a different aspect. It often involves not only maintenance of quality, but the very meaning of quality. It is here that a method which is as independent of the human element as possible can be of tremendous value. For instance, by establishing the actual measurement of a part which satisfies a certain function, and by establishing the dimensional limits within which this part still functions satisfactorily, a decisive insight into the establishment of tolerances and the required manufacturing processes can be gained.

It is equally important if, by the measurement of a part, the causes of its malfunctioning can be established. In development, therefore, it is the function of automatic inspection to deliver fast and unbiased inspection results. This can be performed by tape controlled machines. These same machines can be used to inspect more than one part because programming by tape permits repetition of the measuring function as often as desired. This method is economically applicable for quantities from a few parts to a few hundred parts. If, however, mass production methods are applied in which so-called 100 per cent inspection is not needed because the manufacturing method itself warrants a certain degree of repetition, then the tape controlled inspection machine can be used for sampling inspection. We can therefore speak of three basic applications of tape controlled inspection machines: 1. For single pieces, including those needed in research and development. 2. For 100 per cent inspection of small and medium production. 3. For sampling inspection in large production.

Tape controlled machines are usually economical only if we are dealing with relatively complex parts where an inspector or operator would have to take many measurements, record them, compare them, and perform computations. The tape has the faculty of controlling complex actions and this faculty can be employed in such cases.

I have taken for granted that the basic concept of a tape controlled machine is reasonably well known. Perhaps I should be more specific. A tape controlled machine, whether used for production or inspection, provides a number of movements which may be linear or rotary, and these movements are controlled both as to their sequence, direction, distances traveled, speeds, etc., in accordance with a program. The program is established by patterns of holes in a tape. We use in our machines eight-hole, one-inch tape which, for good reasons, has become something like a standard in our industry, although other tapes are sometimes used. This punched tape contains information which is picked up by a tape reader. The reader, in turn, transmits signals to what is called an information converter, where they are converted into various movements and actions of the machine being controlled.

Fig. 1—Probomat inspection setup automatically measures actual dimensions at predetermined points on turbine blades and impellers, and compares them with nominal dimensions programmed on punched tape. Results are recorded in permanent chart form.

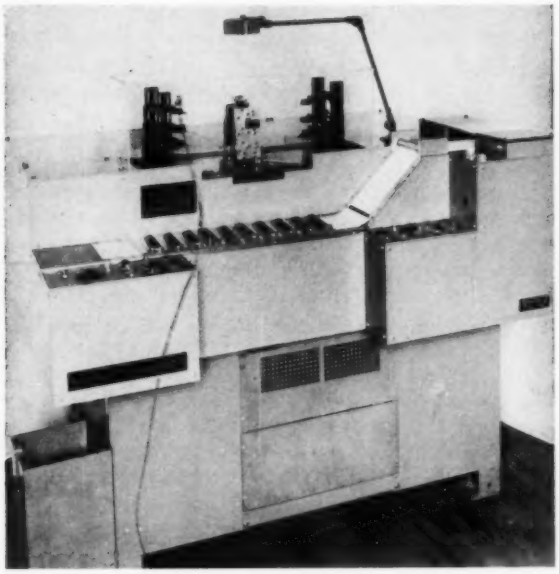


Fig. 2—Probograph inspection machine simultaneously measures up to 50 dimensions on turbine blades. If parts are within tolerances a green light flashes; if outside tolerances, a red light flashes and machine automatically charts all dimensions of defective blades in the form of a graph showing deviations of actual dimensions from nominal.

There are on the market many tape control systems for machine tools. Certain manufacturing operations, such as jig boring, are particularly amenable to this type of control. Processes such as casting and forging of turbine blades, however, are not as easily controlled by tape devices. It is in this area that tape controls can be applied to the *inspection* methods whereby the parts are properly sorted and information is obtained by which the production process can be adjusted and maintained.

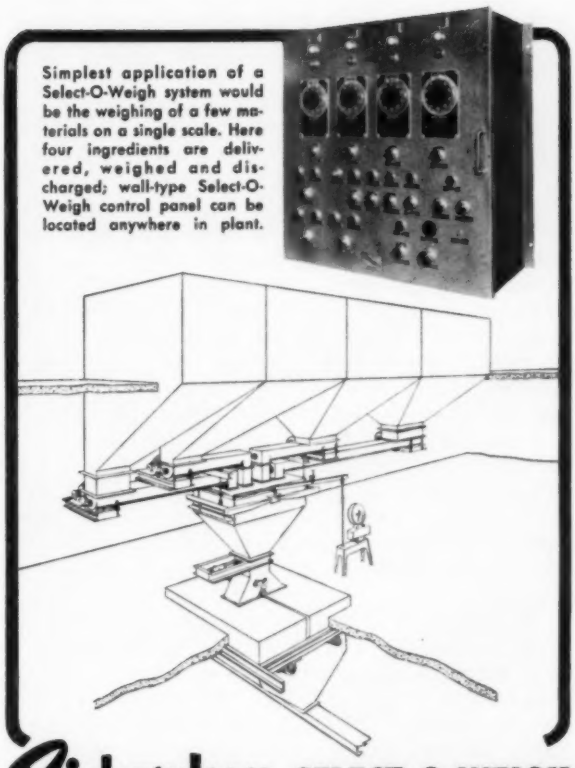
The Probomat tape control system, *Fig.* 1, is a discrete positioning system. It can position a tool or a measuring probe. A discrete position is one which can be defined by co-ordinates. The co-ordinate system chosen may be rectangular or polar.

In simple terms, the tape contains the information by which, for example, a drill may be located to produce a hole in a part to drawing specifications. The tape then actuates the drilling head, retracts the head, and positions the drill at the next desired point. In this manner a series of holes can be drilled automatically at predetermined points. The same system can be applied to boring, punching, milling, and other machine tool operations.

Tape Controlled Inspection

The interesting point is that the same tape can also be used to check or inspect. In this case the tool is replaced by a measuring probe which is positioned by the tape to a point where measuring contact should be made with the part, if the part is correct. The point of contact should be at the nominal dimension of the part. The Probograph, *Fig.* 2, which is a version of the Probomat used as a measuring machine, produces

Simplest application of a Select-O-Weigh system would be the weighing of a few materials on a single scale. Here four ingredients are delivered, weighed and discharged; wall-type Select-O-Weigh control panel can be located anywhere in plant.



Richardson SELECT-O-WEIGH

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The Richardson Select-O-Weigh system electrically controls, in proper sequence, gates, feeders, scales, mixers, conveyors and other materials handling equipment. For proportioning of various solids and/or liquids to make up a finished product, it opens the way to new economies and increased production. The entire Select-O-Weigh system can be supervised by a single operator. No specialized training is required. Service and maintenance is fast and easy.

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a signal indicating where the measured point should be. This signal is recorded on a chart. It then produces a second signal where the measured point actually is. If the two coincide, the part is at its nominal dimension. If the two marks on the chart deviate from each other, the nominal and the actual measuring points deviate from one another; in other words, there is an error. The distance between the two points on the chart indicates the magnitude of the error. Instead of using a chart, the two impulses can be automatically converted into *accept* or *reject* signals. The same method which serves to automatically position a tool can be used to automatically measure the part. The Probograph-Probomat method, in other words, is a tape control system capable of the dual function of controlling machines and measuring. In one case the tool is guided by a program control, in the other case by the measuring probe. This duality of function is quite natural, because essentially the same movements are carried out in measuring and in machining, and the same dimensions are involved; therefore, the same system of tape preparation can be employed.

The philosophy of the Probograph-Probomat method lies in the fact that from the original drawing the same basic dimensional concept should be used throughout manufacture and inspection. This means that the same co-ordinate system that is used in the design should be used through manufacture and inspection. We can go one step further and say that as early as the engineering stages, certain of the co-ordinate dimensions and functions used later on in drafting, manufacture, and inspection are established. Therefore, it is possible in many cases to prepare the tape program for the whole cycle (manufacture and inspection) in the engineering stage. In order to accomplish this, the tape control system has to be so designed that it is applicable to all forms of machine tool control which are susceptible to discrete positioning, and also to measuring functions which are generally of a discrete nature. It is necessary for this purpose to have tape control equipment which can be applied to milling machines, drilling machines, jig borers, boring mills, vertical turret lathes, presses, rolling mills, etc., all using the same basic units and following the same basic concept. Obviously such a control system must be adaptable to a large range of speeds and a large range of accuracies.

The savings that can be achieved by a tape control system which is capable of covering such a broad field, can be substantial. They fall into three categories:

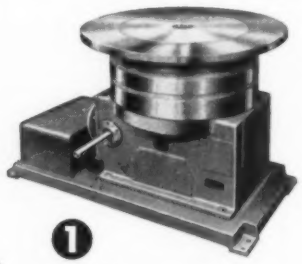
1. The savings on the machine, measuring machine, or machine tool by reducing the human element. Savings of 30 to 50 per cent are considered common; larger savings are reported.

2. Savings by proper balance between inspection and manufacture. These savings are mainly found in inspection and quality control. In certain of our tape controlled machines the quality became so high that inspection could, for all practical purposes, be abandoned. And some of our automatic inspection machines have in turn contributed to substantial im-

Unique Versatility for MOUNTING AND ACTUATING TOOLING

New Series M Chassis Offers Advanced Features for Designing Automatic Machines

The latest addition to the line of indexing machine chassis by Swanson-Erie Corporation is the all-new Series M. These units incorporate extra tool mounting rigidity, particularly in the stationary center area; a number of optional center tool mounting and actuating means, one of which is shown in Photos No. 2 and No. 3; and the same accuracy of position and controlled indexing characteristics inherent in all Swanson turret type chassis.



❶ *Series M chassis less optional accessories, showing 4" diameter center access hole, stationary center plate, ribbed turret, radial tool mounting surface, index camshaft extensions, jackshaft hole, drive housing and floor base.*

❷ *Series M chassis shown with vertically actuated overhead ribbed and cast tool mounting plate.*

❸ *Typical examples of operational tooling mounted to and mechanically actuated from the overhead tool plate.*

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Write for full information on the new Series M Chassis.

provements to the manufacturing process.

3. The most important saving of all will be more fully realized in the future than at the present time. This is in the preparation of the work and in its organization, called data handling.

Savings in production and inspection can be realized immediately by the introduction of tape control. Savings in data handling, for example by having the tape prepared by a central engineering organization, can provide further savings by eliminating costly functions such as the placing of information on drawings, and the reading and understanding of these drawings perhaps by several intermediaries.

By channeling control information directly, and by practically infallible means, from the engineering organization to the machine, a great many errors and misunderstandings can be avoided. Not only is the time for data transmittal shortened, but cost assignable to errors is reduced, and the systems set up to avoid and correct such errors can be eliminated. It is in this phase that the greatest savings can probably be achieved.

We have attempted to prepare for this phase by producing equipment in which standardized control units can be attached to practically any kind of equipment, including existing facilities. Our aim has been to create universally applicable tape controls which can be organized from the data handling phase straight through production and inspection. Full use has been made of existing data handling techniques, computer technology, and automation components, so that the system is fully integrated.

In the final analysis, quality control cannot be separated from production. It is not the purpose of quality control to find faults, but to see to it that the quality is controlled. And quality is best controlled by an integrated automatic system. This may well be one of the most important applications of automation.

From a paper entitled "Automating the Quality Control Function," presented at the Special Manufacturing Conference held by the American Management Association, New York, Nov. 1957.

INTERPRETING ELECTRICAL DIAGRAMS

By F. R. CINCO
Reed-Prentice Corp.
Worcester, Mass.

A COMMON PROBLEM confronting supervision is a lack of qualified personnel who can efficiently maintain and repair production facilities. This problem is particularly acute where electrical work is involved. In such cases, inadequately prepared maintenance personnel are forced to resort to "hit or miss" procedures because of their inability to analyze electrical circuits by means of wiring diagrams. It must be admitted that, through intuitive methods, and by familiarity with the equipment, their conclusions are often correct. Too often, however, there is a long shutdown period while faults are tracked down.

Many hours are expended by manufacturers in designing electrical circuits for their products. Additional

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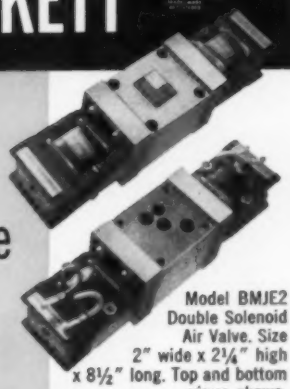
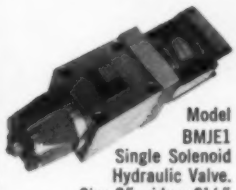
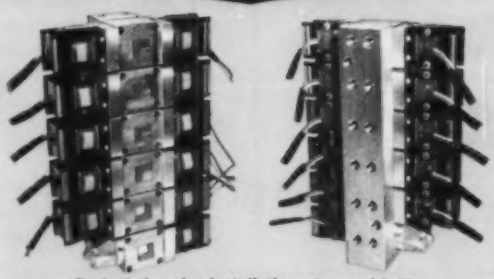

Model BMJE2 Double Solenoid Air Valve. Size 2" wide x 2¼" high x 8½" long. Top and bottom views shown.

Model BMJE1 Single Solenoid Hydraulic Valve. Size 2" wide x 2¼" high x 7¼" long.
Provide extremely compact multiple valve installation with common subplate for automation controls on specialized machine tools and other production equipment.

Typical six valve installation—top and bottom views shown. Block is 12½" long.
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Circle 724 on Page 165

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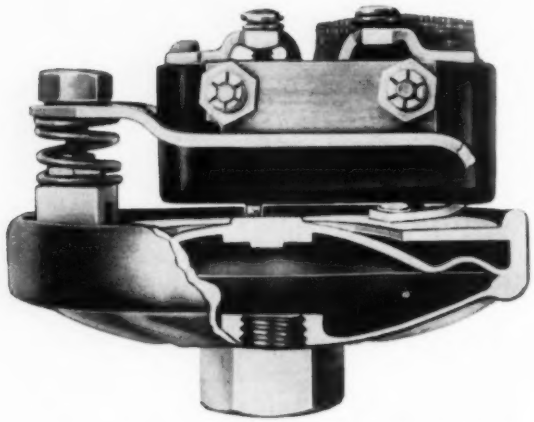

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hours are spent in preparing wiring diagrams. Users can profitably employ these diagrams as guides for maintenance, aids in troubleshooting, and in planning additions to original equipment. Users stand to gain, therefore, to the extent that personnel can make use of these diagrams as tools. The objective, then, becomes that of training responsible user personnel to read and understand electrical wiring diagrams.

The purpose of wiring diagrams is to show the physical layout of electrical devices used on the control panel and on the machine, to show the electrical assembly together with the interconnections, and to show the manner in which the controlled devices function in relation to each other.

To most readily impart this information, the wiring diagram is divided into two sections designated *interconnection* and *elementary*. The interconnection diagram is a pictorial layout of the control panel with the devices shown in their approximate forms and locations. This diagram also shows the electrical units that are mounted on the machine—such as pushbuttons, limit switches, solenoid valves, and timers—and gives their relative locations. The manner in which all of the electrical components are interconnected is shown by connecting lines or a wiring table.

The elementary diagram, on the other hand, is the source of operational information. It is a simplified line drawing, showing the necessary elements in their electrical functioning relation to each other irrespective of actual physical location. Symbols, rather than outline drawings, are used.

In an effort to reach a common trade understanding, various standards and code committees have established tables of symbols to represent all of the electrical devices and components normally used in industrial machinery. A few of the symbols that are outlined in the Joint Industry Conference (JIC) and National Machine Tool Builders Association (NMTBA) electrical codes are shown in *Fig.* 1.

Reading Elementary Diagrams

To a beginner, an elementary diagram appears complicated. Learning to read one can be facilitated by first considering a basic circuit, *Fig.* 2. Here, power lines 1 and 2 supply current to an ordinary electric

TYPICAL GRAPHICAL SYMBOLS FOR ELECTRICAL DIAGRAMS

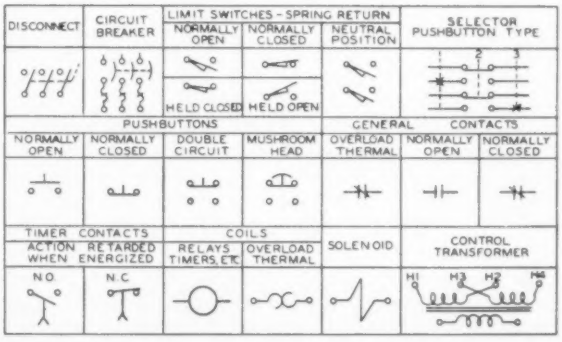

Fig. 1—Some common graphical symbols used in elementary wiring diagrams to represent electrical components.

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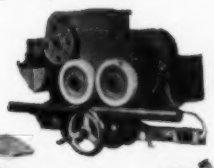

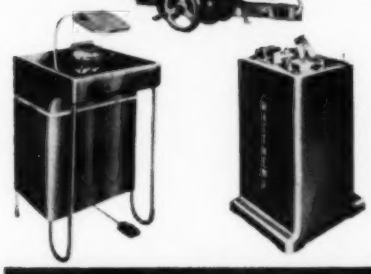

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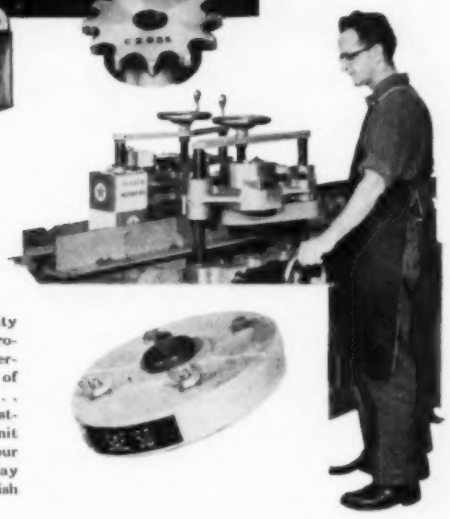

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Circle 726 on Page 165

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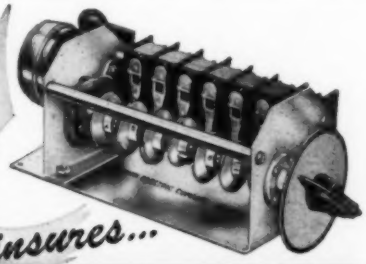

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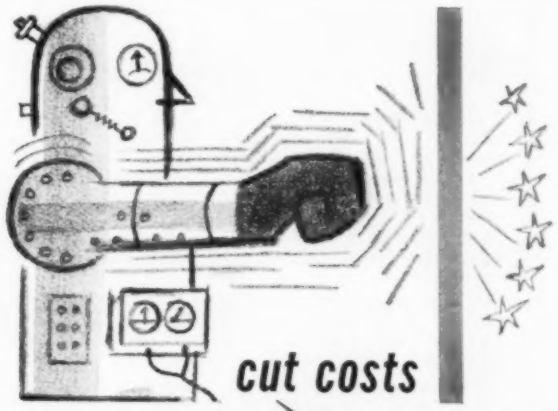

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Solenoid Operated Production Tools

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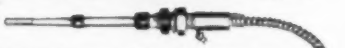
Improved Operation of literally hundreds of mechanical products has been effected with Acco Tru-Lay *flexible* PUSH-PULL Controls

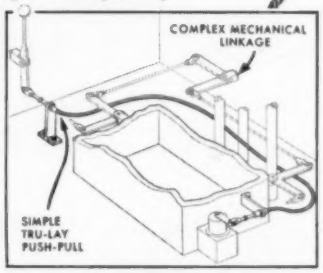


Tru-Lay Push-Pull Controls provide POSITIVE REMOTE-ACTION over long or short distances . . . with fixed or movable anchorages . . . for light loads or loads up to 1,000 lbs., and these units are frequently and successfully used in conjunction with Electric, Hydraulic and Air Controls.

Flexibility makes it possible to snake around obstructions . . . simplifies installation . . . reduces the number of working parts . . .

Simplicity vs Complexity

Compare the TRU-LAY PUSH-PULL cable in illustration with the mechanical linkage. PUSH-PULLS are simple, have but one moving part, are noiseless and give lifetime service accuracy. Linkages are complex, made of many parts; they wear at many points. Their use brings increased backlash, lost accuracy and vibration rattles.



Positive Remote-Action and Flexibility, together with Precision and Long Life, explain why TRU-LAY PUSH-PULLS serve designers and users equally well in improving machine operations, whether the application is on such severe service jobs as Bulldozers, Power Shovels and Steel Mill Machinery, or on such light duty work as Photographic Equipment, X-Ray or Business Machines.

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light when the normally open toggle switch is closed. Although representing the hookup for an ordinary house light and wall switch, the circuit is representative of a broad class of circuits used in industrial applications. For example, its principle of operation can readily be extended to cover practically all magnetic or resistance circuits involving a load and an actuating means. Loads, for example, may be starter coils, relay coils, timers, solenoids, or motors. Actuating means may be pushbuttons, selector switches, limit switches, relay contacts, or combinations of the same.

By keeping in mind the electrical symbols of *Fig.* 1 and the basic circuit of *Fig.* 2, a more complex circuit, *Fig.* 3, can be followed. This is the elementary diagram for a plastics molding press which includes a pump motor and associated protective devices, a moving die plate, an injection plunger operated by spring offset, and solenoid operated valves. Operating sequence is such that after the pump motor is started, actuation of a pushbutton causes the dies to close. When the dies close and lock, a limit switch signals the plunger to move forward. After a time delay the dies open, completing the cycle and resetting the controls.

Functioning of the machine may be determined from an inspection of the elementary diagram of *Fig.* 3 in the following manner:

1. With the disconnect switch closed, pressing the *Pump Start* button (*PB*2) energizes starter coil *M*1. This coil remains energized even after the *Pump Start* button is released because of interlock contact *M*1 which bridges *PB*2 at terminals 3-4. Since all contacts designated *M*1 close and remain closed together, power is applied to the pump motor.

2. With the pump in operation, pressing the *Dies Close* button (*PB*4) energizes the coil of relay *CR*1. An interlock circuit across *PB*4 keeps this coil energized. Another contact on relay *CR*1 energizes solenoid *A*, and the dies close. Limit switch *LS*1 is closed by this action, *SOL B* is energized, and the plunger advances.

3. Timer *T*2 then times out. At the end of its preset time interval, its contact opens and breaks the circuit to relay *CR*2 and thus to *SOL B*. Since this solenoid is a spring-offset type, de-energization causes the plunger to return.

4. Timer *T*1 next times out and opens the circuit

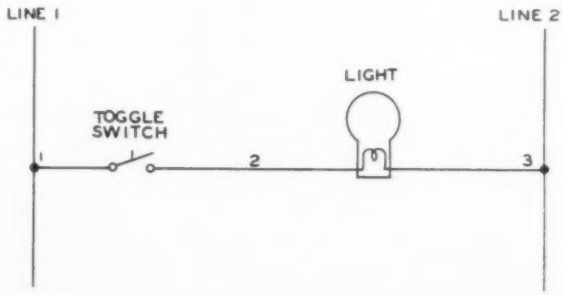

Fig. 2—Simple electrical diagram illustrates use of symbols and lines to portray actual components and show their interconnections. Light receives power from lines 1 and 2 when normally open toggle switch is closed.

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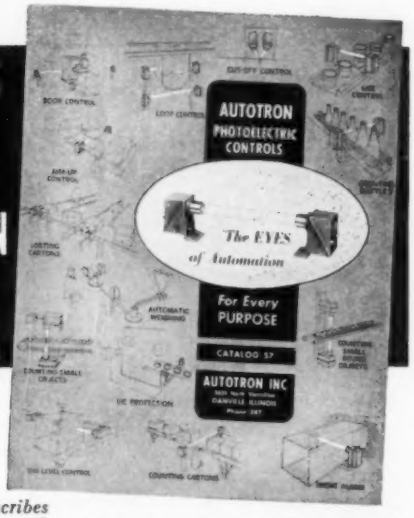

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Circle 732 on Page 165

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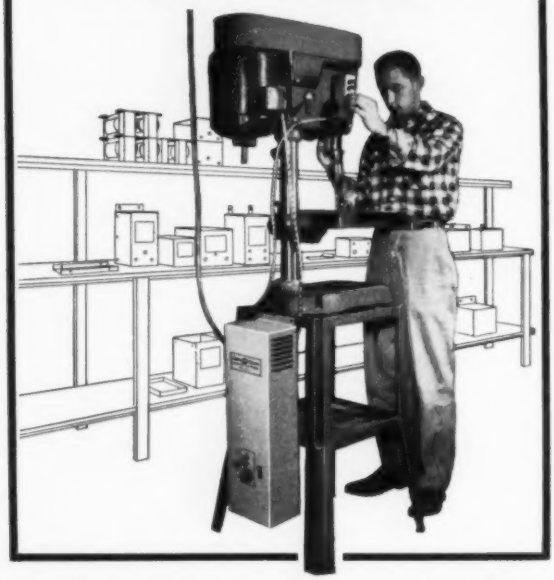

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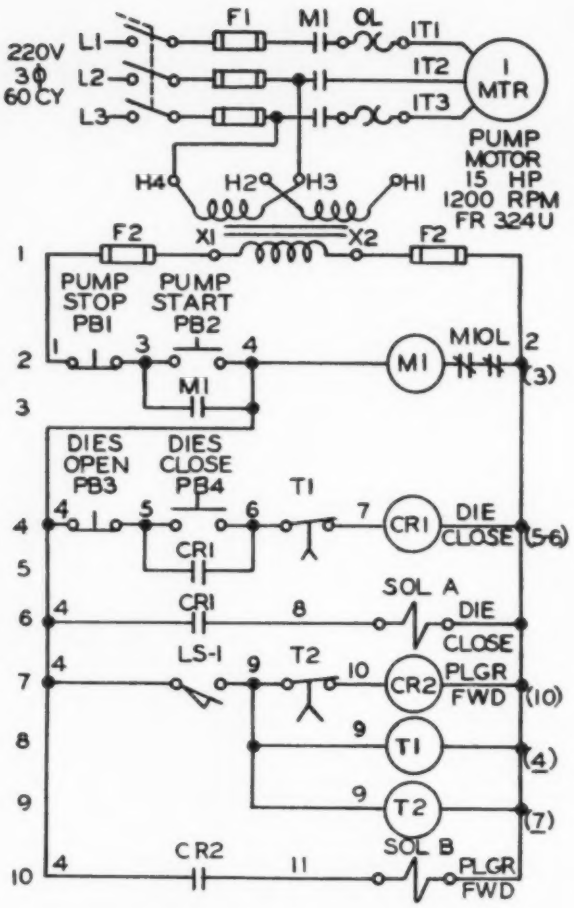

Fig. 3—Elementary diagrams such as this one for a plastics molding press are useful in troubleshooting, maintenance, and in planning and making changes or additions to original equipment.

to relay *CR*1. *SOL A* is thus de-energized and the dies open.

5. As the dies open, limit switch *LS*1 opens, allowing timers *T*1 and *T*2 to reset for the next cycle.

Elementary diagrams of the type described are a powerful tool for the troubleshooter. For instance, if *SOL A* in the machine should fail to operate when the *Dies Close* button is pressed, a clue as to the cause would be sought on the diagram. It would be relay contact *CR*1. If this contact is found to be functioning properly, it could next logically be deduced that the fault is a broken or disconnected wire in its circuit, or failure of solenoid *A* itself.

While this example may appear extremely simple, it serves to point out the usefulness of elementary diagrams in the location of faults in electrical equipment. A better understanding of the equipment, and savings in downtime, are additional benefits obtainable through use of this important tool.

From a paper entitled "Wiring Diagrams—Their Purpose And How To Understand Them," presented at the Fourteenth Annual National Technical Conference of the Society of Plastics Engineers, Detroit, Jan. 1958.

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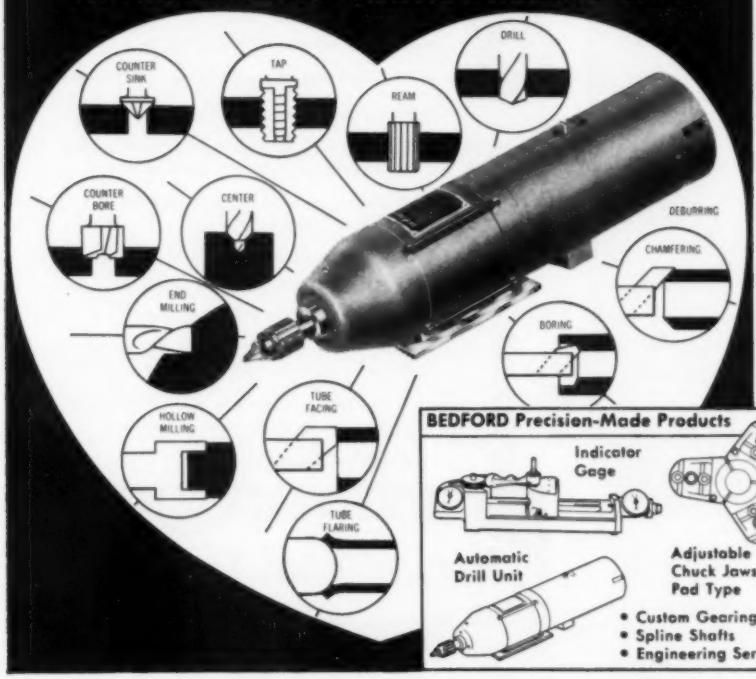

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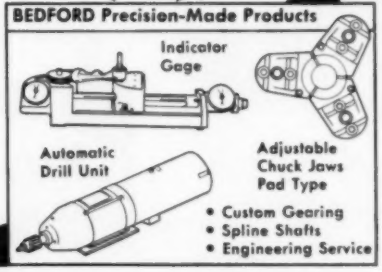

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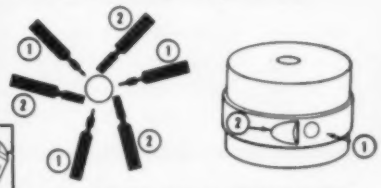

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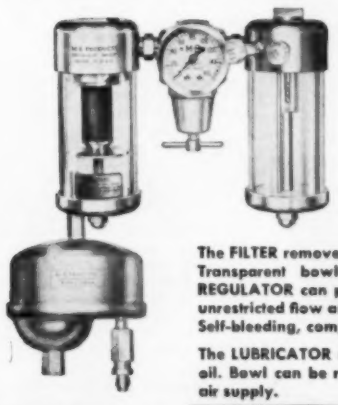

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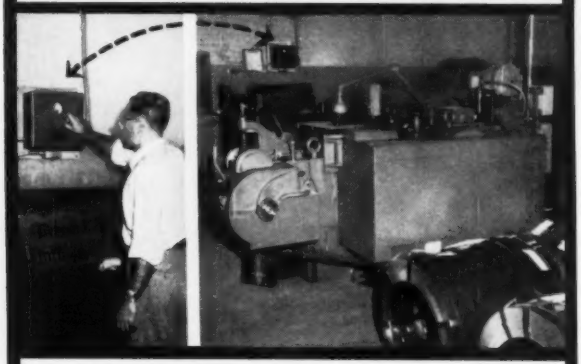

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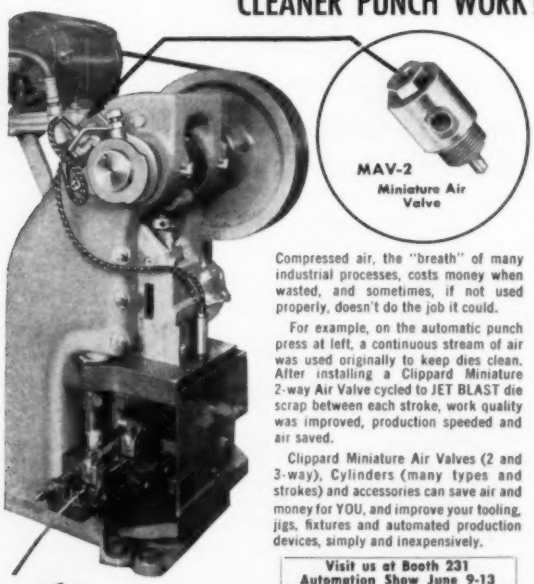

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AUTOMATION patents

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APPARATUS FOR AND METHOD OF RECORDING

Continuous tubular member feeds past a recording station which rotates about the tubular member to produce a spiral record track. Patent 2,809,238 by James P. Fay, assigned to Teletrak Corp.

CAPPING MACHINE

Series of caps are introduced into a cap chamber. Sensing means causes chamber to rotate 180 degrees whenever a cap is incorrectly aligned. Oriented caps then move to a capping means for placement on containers. Patent 2,810,248 by George H. Dimond, assigned to Consolidated Packaging Machinery Corp.

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MAGNETIC SEPARATION DEVICE

Series of magnets move along a guideway and are individually energized while over a conveyor. Magnetic material is separated from nonmagnetic material on the conveyor and moved to a dump position at another point of the guideway. Patent 2,811,256 by Robert M. Chambers.

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This book is directed at management aspects of automation and is not meant to cover technical details. It is organized in three sections. The first section deals with the background and definition of automation and includes a scale of mechanization having 17 levels. The second section sets forth experiences with automation at 13 plants in a variety of industries. The third section discusses the impact of automation on maintenance, personnel, sales, and management itself.

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BASIC PHYSICS

By Alexander Efron, chairman, physics department, Stuyvesant High School, New York; 692 pages, 6½ by 9⅛ inches, illustrated, clothbound, published by John F. Rider Publisher Inc., New York; available from AUTOMATION; *$8.95 postpaid.*

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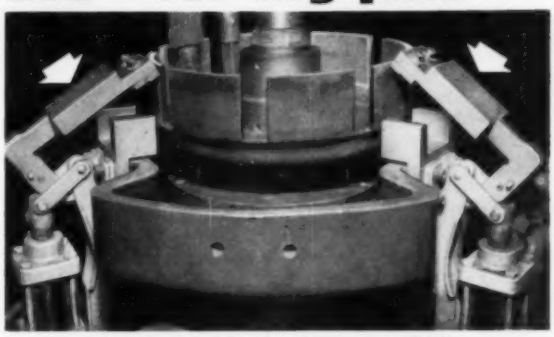

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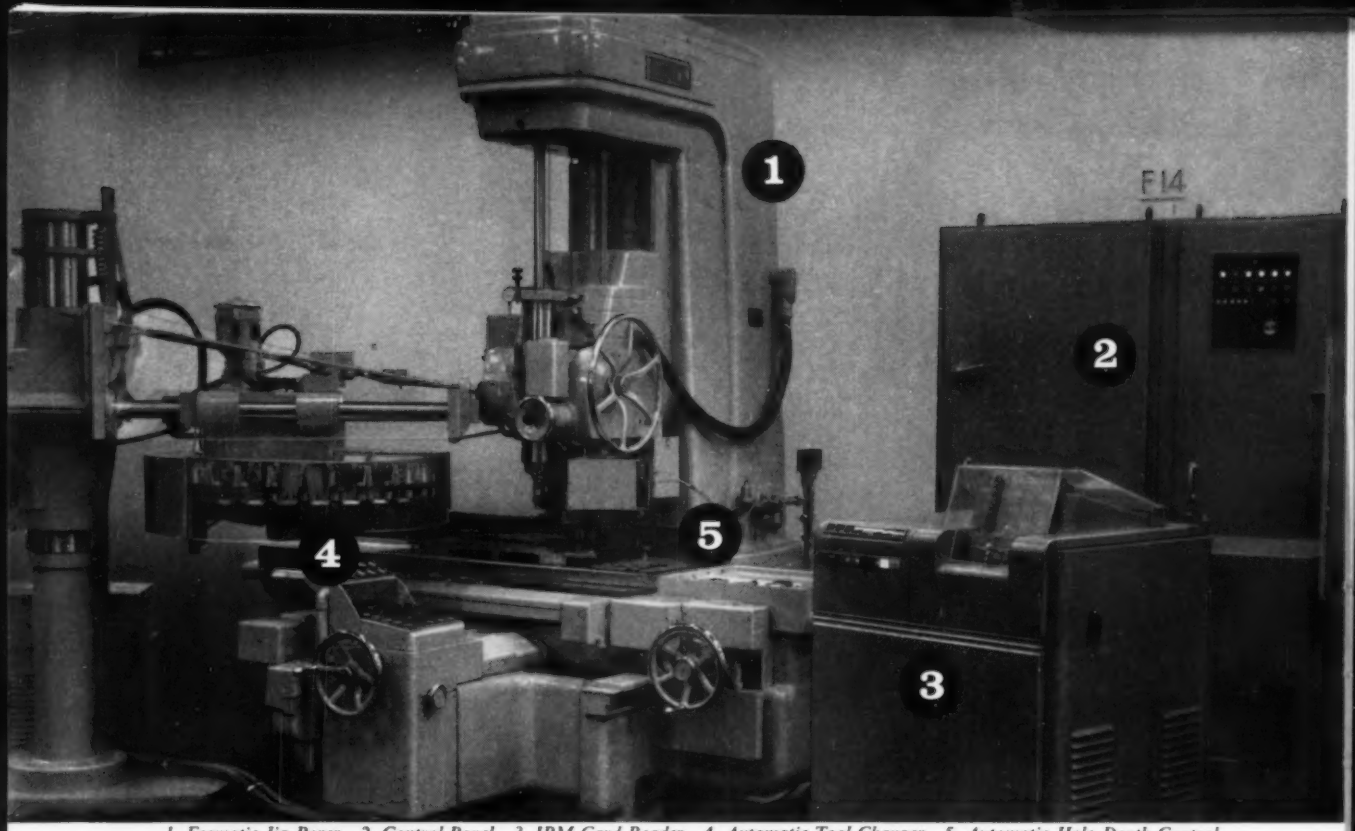

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Transmission Equipment

Lovejoy Flexible Coupling Co., 4949 W. Lake St., Chicago 44, Ill.—83 page catalog—Catalog is divided into several sections. Flexible coupling section covers specifications and dimensions, types and materials. Power transmission equipment section describes variable speed pulleys, wide V-belts, sheaves, motor bases, and adjustable speed transmissions. Shaft mounted gear reducer section gives data on the proper selection, dimensions, and lubrication for various reduction units.

Circle 473 on Page 165

DC Crane Controls

Clark Controller Co., 1146 E. 152nd St., Cleveland 10, Ohio—20 page booklet—Selection and application of crane control equipment are discussed in Bulletin 9100. Basic dc hoist circuit, bridge and trolley motions, and the components which make up the crane control systems are explained. Specifications, performance curves, and dimensions are noted.

Circle 474 on Page 165

Cold Roll Forming

Yoder Co., 5500 Walworth Ave., Cleveland 2, Ohio—88 page handbook—Equipment and process of cold roll-forming are described and illustrated. Some of the operations covered are surface finishing, fabrication and welding, slitting lines, moldings and trim, and forming structural shapes. Auxiliary equipment for curving, ring-forming, notching, perforating, automatic cut-off, and other operations which can be incorporated in production lines is also described.

Circle 475 on Page 165

Arc Welding Machines

Resistance Welder Corp., Bay City, Mich.—2 page pamphlet—Bulletin ARC 5803 describes and illustrates four models of automatic arc welding machines. Applications and features are noted.

Circle 476 on Page 165

Straight Line Indexing Machine

Swanson-Erie Corp., 814 E. 9th St., Erie, Pa.—8 page bulletin—Unit which can be used as the basis for an automatic special machine, or as a transfer machine, is explained. Dimensions, index time, and cycling data are given. Optional accessories such as carrier suspension, horizontal tool mounting, air manifold, and electric control panel are described.

Circle 477 on Page 165

Transductors

Control, Div., Magnetics Inc., Butler, Pa.—16 page booklet—Functions of transductors are explained in Catalog T-10. Line of units which has two designs, one open for bus bar use and one enclosed for cable service, is described. Transductor capabilities and applications are noted. Tables list electrical characteristics and dimensions.

Circle 478 on Page 165

Fluid Power Drives

Oilgear Co., 1571B W. Pierce St., Milwaukee 4, Wis.—32 page handbook—Advantages, operation, and characteristics of fluid power speed drives are noted in Bulletin 10600. Performance curves and block diagrams on different types of rotary applications are given. Also included are diagrams for systems requiring constant power, constant torque, multiple series and servo controlled electrohydraulic feedback drives.

Circle 479 on Page 165

Motor Protectors

Spencer Thermostat Div., Metals & Controls Corp., 34 Forest St., Attleboro, Mass.—4 page pamphlet—Applications and advantages of 3-phase motor protectors are noted in Bulletin PR-1243. Typical questions are answered for problems such as overtemperature conditions, cost saving, and protection on motors with magnetic control.

Circle 480 on Page 165

Surface Finishes

Micrometrical Mfg. Co., 345 S. Main St., Ann Arbor, Mich.—14 page booklet—Line of shop equipment for measuring surface roughness is described in Catalog 157. Data on tracers for straight-line mechanical tracing, for measurements on short, smooth and hard-to-reach surfaces, and for measurements across internal grooves and recesses, is given. Also described is a special Profilometer for automatic sorting of parts according to surface roughness.

Circle 481 on Page 165

Power Lubrication

Lincoln Engineering Co., Div., McNeil Machine & Engineering Co., St. Louis 20, Mo.—8 page bulletin—Power lubrication by automatic centralized systems is described in Bulletin 811R. Three types of lubrication systems, and controls for these systems are explained. The selection of the proper system is also discussed. Various air-operated lubrication pumps are mentioned and illustrated.

Circle 482 on Page 165

Finishing Machines

Gisholt Machine Co., 1245 E. Washington Ave., Madison 10, Wis.—44 page handbook—Fifteen models of finishing machines and three attachments are described in Bulletin 1169-B. Also included are sections on automatic size control, the engineering service available, and floor plans for all the models. Nine pages of illustrative examples of applications are given.

Circle 483 on Page 165

Speed Measuring Systems

General Electric Co., 1 River Rd., Schenectady 5, N. Y.—8 page bulletin—Line of tachometer instruments and generators for industrial speed measurement is described in Bulletin GED-3259. Custom-marked scales, dual scales, and color bands for tachometer instruments required for machine tools, paper, textile and steel machinery are covered.

Circle 484 on Page 165

Paper Handling

Lewis-Shepard Products Inc., Dept. R8-7, 125 Walnut St., Watertown 72, Mass.—2 bulletins—Two case histories describe how paper handling problems are solved. Bulletin 264-1 covers the step by step operation of a gravity-feed rack and fork lift truck system for storing and handling sensitized paper. Bulletin 261-1 discusses how a maximum inventory of paper is stored in limited space.

Circle 485 on Page 165

Power Supplies

Electronic Measurements Co. Inc., Eatontown, N. J.—8 page bulletin—Bulletin 765 explains how power supplies can be used in automatic systems. Described are automatic high-speed transistor tests, motion-to-voltage conversion, strain gage instrumentation, and similar applications.

Circle 486 on Page 165

Automatic Conveyors

Hanson-Van Winkle-Munning Co., Church Street, Matawan, N. J.—4 page pamphlet—Conveyors designed for the metalfinishing industry are described in Bulletin FAC-103. The Dial-A-Cycle system, which allows nine or more anodizing or plating operations to be automatically carried out under the control of one

new catalogs..... latest literature

operator, is explained. Also included are illustrations showing applications such as electroplating, anodizing, metal cleaning, and phosphating. An automatic load and unload system for handling whole carrier racks of heavy parts is also mentioned.

Circle 487 on Page 165

Automatic Controls

Mercoid Corp., 4201 Belmont Ave., Chicago 41, Ill.—60 page catalog—Data on controls for pressure, temperature, liquid level, and mechanical movement are given in Catalog 858. Specifications, features, and construction are noted. Information on relays and magnetic and tilting type mercury switches is also included.

Circle 488 on Page 165

Resistance Welding Machines

Sciaky Bros. Inc., 4915 W. 67th St., Chicago, Ill.—32 page handbook—Various resistance welding techniques, such as seam welding and cross wire welding, and their application on a wide range of products are discussed in Bulletin 341. How special fabricating problems are solved—the adaptation of resistance welding to the production processes—is explained and illustrations of different models in the line are given.

Circle 489 on Page 165

Adjustable Speed Drive

Louis Allis Co., 427 E. Stewart St., Milwaukee 7, Wis.—16 page booklet—AC adjustable speed drive, consisting of conventional squirrel cage ac motor, an electromagnetic clutch, and a pilot governor, is described in Bulletin 611 E. Construction of the components, such as the electronic control panel and pushbutton control station, is explained. Illustrative examples of typical applications are given.

Circle 490 on Page 165

Flame-Cutting Machines

Linde Co., Div. Union Carbide Corp., 30 E. 42nd St., New York 17, N. Y.—28 page handbook—Line of flame-cutting machines which range in size from small portable machines to large multiblowpipe shape-cutting machines, is described in Bulletin 4487. Specifications are listed and accessories such as automatic and magnetic tracing units are outlined. Illustrative examples of typical installations are given.

Circle 491 on Page 165

Comparator Gages

Moore Products Co., H & Lycoming Sts., Philadelphia 24, Pa.—8 page bulletin—Hardcoat pneumatic plugs, two-dimension master rings, set-lock gaging stands, set-lock chromium plugs, and an automation controller are described. Developments in automatic gaging are discussed, and illustrations show different applications.

Circle 492 on Page 165

Gear Reducers

Crichton Co., 520 Vine St., Johnstown, Pa.—12 page booklet—Seven gear reducers with ratios from 3.5:1 to 216:1 are described. Specifications are listed, and mechanical efficiency and thermal efficiency noted. Method of finding horsepower rating is explained.

Circle 493 on Page 165

Counting Scales

Pennsylvania Scale Co., Bareville, Pa.—16 page booklet—Line of precision ratio counting scales covering a range of counting from the smallest parts weighing a few milligrams per piece, up to a maximum quantity weight of 50 pounds, is described in Bulletin PS-C140. Construction features are explained and illustrated. Specifications, dimensions, ratios, and applications are given.

Circle 494 on Page 165

Shaft Retention Fasteners

Fastex Div., Illinois Tool Works, 195 Algonquin Rd., Des Plaines, Ill.—8 page bulletin—Line of shaft retention fasteners for use in assembling such items as controls, rectifiers, and condensers is described. The pilot tooth design is explained and illustrated. Dimensions and specifications are listed.

Circle 495 on Page 165

Flow Colorimeter

Process Instruments Div., Beckman Instruments Inc., 2500 Fullerton Rd., Fullerton, Calif.—4 page pamphlet—Model 77, flow colorimeter, an instrument which continuously measures color intensity, turbidity, or chemical concentration in a wide variety of process streams, is described in Bulletin 4000. Operating principle of the ratio recorder is explained, and specifications noted. Photographs and drawings illustrate the instruments and typical installations.

Circle 496 on Page 165

Analog Computer

Mid-Century Instrumatic Corp., 611 Broadway, New York 12, N. Y.—8 page bulletin—Model MC-400, a desk side analog computer which provides a portable computer center, is the subject of brochure. An illustration of the cabinet indicates the position of the different parts. Data on the operational amplifiers, removable patchboards, and 3-way amplifiers are given.

Circle 497 on Page 165

Automatic Lathe

Seneca Falls Machine Co., 14 Fyfe Bldg., Seneca Falls, N. Y.—6 page pamphlet—New double-way, tracer type automatic lathes are described in Bulletin Q-57. The operating principles are explained, and specifications and features are listed. Diagrams of tooling set-ups, chip disposal methods, and types of turning and squaring carriages are also included.

Circle 498 on Page 165

Pneumatic Tube Systems

Grover Co., 25525 W. Eight Mile Rd., Detroit 19, Mich.—36 page handbook—Line of pneumatic tubes is described and illustrated. Principles of several systems are explained, and diagrams show different layouts. Accessories permitting automatic systems to be built are covered.

Circle 499 on Page 165

Arc Welding Cable Connections

Tweco Products Inc., P. O. Box 666, Wichita 1, Kans.—12 page booklet—Line of arc welding cable connections and accessories is covered in Bulletin 11. Specifications and prices are listed. Hints on installing the units are also given.

Circle 500 on Page 165

Thermal Elements

Partlow Corp., 505 Campion Rd., New Hartford, N. Y.—4 page pamphlet—Bulletin 110 covers more than 400 separate corrosive atmospheres into which temperature control elements are immersed. Charts list the recommended bulb material and other data, and provides an easy means for selecting the thermal elements which offer maximum resistance to corrosive atmospheres.

Circle 501 on Page 165

Relay Terms

Potter & Brumfield, Inc., Princeton, Ind.—16 page booklet—Definitions of relay terms suggested by National Association of Relay Manufacturers are compiled in booklet. Also included are twenty-one diagrams illustrating contact arrangements and voltage and current parameters.

Circle 502 on Page 165

Marking Machines

Markem Machine Co., Keene 43, N. H.—8 page bulletin—Machines for marking components, parts, products, and packages used in the electrical and electronic industries are described. Information such as imprint size, object size, operating speed, and printing head are given. Illustrations of machines for flat items and surfaces, tapes and labels, tubing, wire, and irregular shapes are included.

Circle 503 on Page 165

Remote Control Meters

Builders-Providence Inc., 345 Harris Ave., Providence 1, R. I.—8 page bulletin—Bulletin 230-P4 explains how Telemeters

can be adapted to a wide range of industrial applications such as metering, observing, and recording fluid flow, position, liquid level, and temperature. Operating principle is discussed and illustrative examples of installations are included.

Circle 504 on Page 165

Instrument Components

PIC Design Corp., 477 Atlantic Ave., East Rockaway, L. I., N. Y.—128 page catalog—Technical data on shafts, gears, collars, couplings, screws and washers, bearings, and mounting plates are included in Catalog 14. Development kits are described and illustrated. Charts listing specifications, information on screw heads and drills and taps are also given.

Circle 505 on Page 166

Pressure Gages

Kunkle Valve Co., 120 S. Clinton, Ft. Wayne, Ind.—48 page catalog—Gages for air, gas, vapors, and liquids with ranges from 15 psi to 20,000 psi are outlined in Catalog G-58. Engineering data and selection tables for applications in processing plants and power instrumentation are given. Accessories for gages are also mentioned.

Circle 506 on Page 165

Selenium Rectifiers

Electric Products Div., Vickers Inc., 1815 Locust St., St. Louis 3, Mo.—48 page handbook—Rectifiers using grain-oriented selenium are discussed in Bulletin EPD-3116-1. Cell construction, protective finish, and conversion efficiency are explained. Data on the proper selection and application of rectifiers are given and notes on installation and care are also included.

Circle 507 on Page 165

Boron Nitride

Carborundum Co., P. O. Box 337, Niagara Falls, N. Y.—4 page pamphlet—Boron nitride, a machinable, impermeable ceramic material with electrical and corrosion resistance properties suitable for use up to 3000 F is subject of brochure. Advantages, properties, and applications are explained. Typical analysis of boron nitride and tabulations of its various chemical and physical properties are given.

Circle 508 on Page 165

Process Vapor Fractometer

Instrument Div., Perkin-Elmer Corp., Norwalk, Conn.—12 page booklet—Automatic plant stream analysis by gas chromatography is the subject of booklet. Model 184 process vapor fractometer, an instrument designed for the analysis of gases and light liquids in chemical and petroleum processing streams, is described. Function and construction of the sensing unit and programmer are explained. Charts showing typical analysis are included.

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404	444	484	524	564	604	644	684	724	764	804
405	445	485	525	565	605	645	685	725	765	805
406	446	486	526	566	606	646	686	726	766	806
407	447	487	527	567	607	647	687	727	767	807
408	448	488	528	568	608	648	688	728	768	808
409	449	489	529	569	609	649	689	729	769	809
410	450	490	530	570	610	650	690	730	770	810
411	451	491	531	571	611	651	691	731	771	811
412	452	492	532	572	612	652	692	732	772	812
413	453	493	533	573	613	653	693	733	773	813
414	454	494	534	574	614	654	694	734	774	814
415	455	495	535	575	615	655	695	735	775	815
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418	458	498	538	578	618	658	698	738	778	818
419	459	499	539	579	619	659	699	739	779	819
420	460	500	540	580	620	660	700	740	780	820
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422	462	502	542	582	622	662	702	742	782	822
423	463	503	543	583	623	663	703	743	783	823
424	464	504	544	584	624	664	704	744	784	824
425	465	505	545	585	625	665	705	745	785	825
426	466	506	546	586	626	666	706	746	786	826
427	467	507	547	587	627	667	707	747	787	827
428	468	508	548	588	628	668	708	748	788	828
429	469	509	549	589	629	669	709	749	789	829
430	470	510	550	590	630	670	710	750	790	830
431	471	511	551	591	631	671	711	751	791	831
432	472	512	552	592	632	672	712	752	792	832
433	473	513	553	593	633	673	713	753	793	833
434	474	514	554	594	634	674	714	754	794	834
435	475	515	555	595	635	675	715	755	795	835
436	476	516	556	596	636	676	716	756	796	836
437	477	517	557	597	637	677	717	757	797	837
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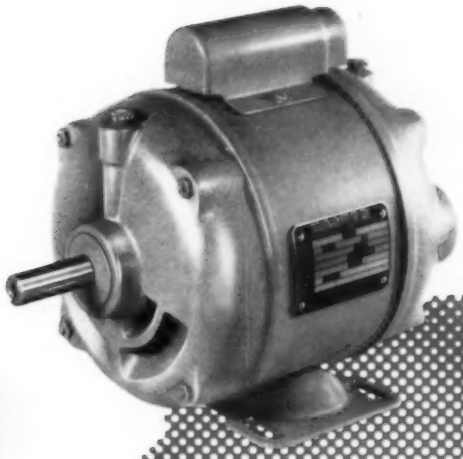

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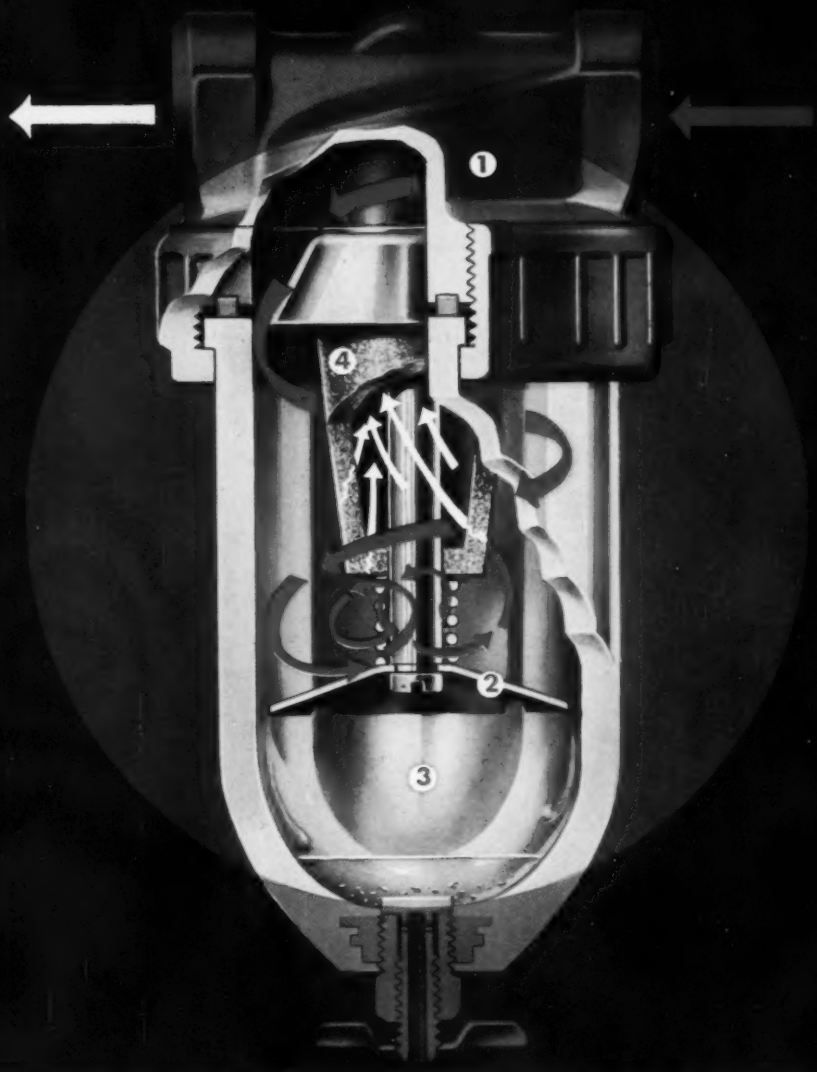

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